U.S. Fish & Wildlife Service

# James Campbell National Wildlife Refuge

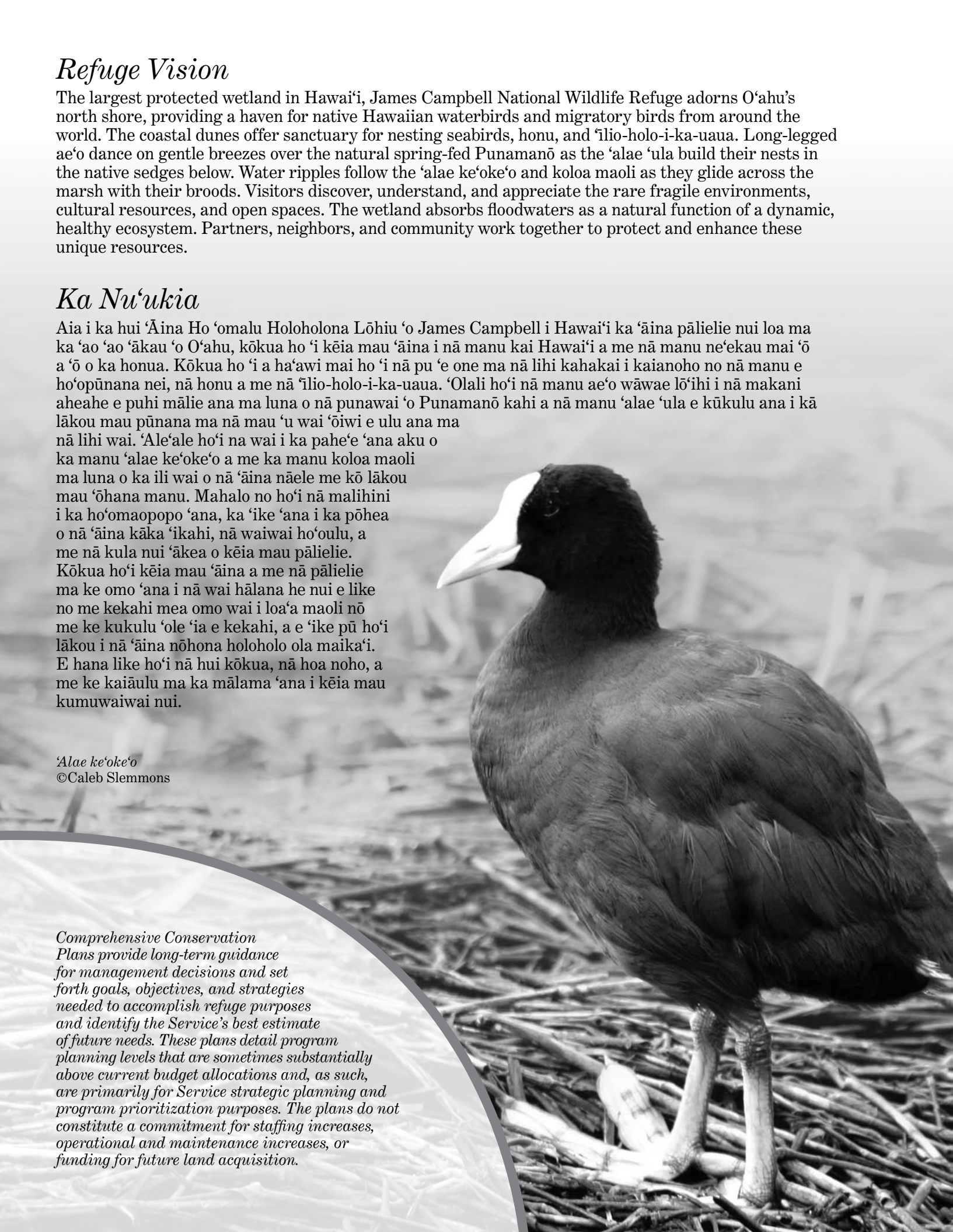
*Draft Comprehensive Conservation Plan and Environmental Assessment*

# *Refuge Vision*

The largest protected wetland in Hawai‘i, James Campbell National Wildlife Refuge adorns O‘ahu’s north shore, providing a haven for native Hawaiian waterbirds and migratory birds from around the world. The coastal dunes offer sanctuary for nesting seabirds, honu, and ʻīlio-holo-i-ka-uaua. Long-legged ae‘o dance on gentle breezes over the natural spring-fed Punamanō as the ‘alae ‘ula build their nests in the native sedges below. Water ripples follow the ‘alae ke‘oke‘o and koloa maoli as they glide across the marsh with their broods. Visitors discover, understand, and appreciate the rare fragile environments, cultural resources, and open spaces. The wetland absorbs floodwaters as a natural function of a dynamic, healthy ecosystem. Partners, neighbors, and community work together to protect and enhance these unique resources.

# *Ka Nu‘ukia*

Aia i ka hui ʻĀina Ho ‘omalu Holoholona Lōhiu ‘o James Campbell i Hawai‘i ka ‘āina pālielie nui loa ma ka ‘ao ‘ao ‘ākau ‘o O‘ahu, kōkua ho ‘i kēia mau ‘āina i nā manu kai Hawai‘i a me nā manu ne‘ekau mai ‘ō a ‘ō o ka honua. Kōkua ho ‘i a ha‘awi mai ho ‘i nā pu ‘e one ma nā lihi kahakai i kaianoho no nā manu e ho‘opūnana nei, nā honu a me nā ʻīlio-holo-i-ka-uaua. ‘Olali ho‘i nā manu ae‘o wāwae lō‘ihi i nā makani aheahe e puhi mālie ana ma luna o nā punawai ‘o Punamanō kahi a nā manu ‘alae ‘ula e kūkulu ana i kā lākou mau pūnana ma nā mau ‘u wai ‘ōiwi e ulu ana ma nā lihi wai. ‘Ale‘ale ho‘i na wai i ka pahe‘e ‘ana aku o ka manu ‘alae ke‘oke‘o a me ka manu koloa maoli ma luna o ka ili wai o nā ‘āina nāele me kō lākou mau ‘ōhana manu. Mahalo no ho‘i nā malihini i ka ho‘omaopopo ‘ana, ka ‘ike ‘ana i ka pōhea o nā ‘āina kāka ‘ikahi, nā waiwai ho‘oulu, a me nā kula nui ‘ākea o kēia mau pālielie. Kōkua ho‘i kēia mau ‘āina a me nā pālielie ma ke omo ‘ana i nā wai hālana he nui e like no me kekahi mea omo wai i loa‘a maoli nō me ke kukulu ‘ole ‘ia e kekahi, a e ‘ike pū ho‘i lākou i nā ‘āina nōhona holoholo ola maika‘i. E hana like ho‘i nā hui kōkua, nā hoa noho, a me ke kaiāulu ma ka mālama ‘ana i kēia mau kumuwaiwai nui.



*‘Alae ke‘oke‘o*
©Caleb Slemmons

*Comprehensive Conservation Plans provide long-term guidance for management decisions and set forth goals, objectives, and strategies needed to accomplish refuge purposes and identify the Service’s best estimate of future needs. These plans detail program planning levels that are sometimes substantially above current budget allocations and, as such, are primarily for Service strategic planning and program prioritization purposes. The plans do not constitute a commitment for staffing increases, operational and maintenance increases, or funding for future land acquisition.*

# James Campbell National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessment

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# Readers' Guide

Native species discussed in this document are referred to by their Hawaiian names. Common English names and scientific nomenclature can also be found in the glossary in Appendix A. The U.S. Fish and Wildlife Service endeavors to be accurate in its use of the Hawaiian language and correctly spell Hawaiian words, including the diacritical marks that affect the meaning and aid in pronunciation. This guide is provided to simplify pronunciation for the reader.

When Captain Cook arrived in the Hawaiian Islands in 1778, the Hawaiians had a totally oral tradition. In 1820, western missionaries standardized a written version of the Hawaiian language that features 8 consonants and 5 vowels.

**Consonants**

H - as in English
K - as in English
L - as in English
M - as in English
N - as in English
P - as in English
W - after i and e pronounced v
- after u and o pronounced like w
- at the start of a word or after a, pronounced like w or v
(ʻ) - ʻokina - a glottal stop

**Vowels**

A - pronounced like the a in far
E - pronounced like the e in bet
I - pronounced like the ee in beet
O - pronounced like the o in sole
U - pronounced like the oo in boot

**Special Symbols**

Two symbols appear frequently in Hawaiian words... the ʻokina and the kahakō. These two symbols change how words are pronounced. The ʻokina itself looks like an upside-down apostrophe and is a glottal stop – or a brief break in the word. An example of this in English is in the middle of the expression "uh-oh." The ʻokina is an official consonant – just as any of the other consonants.

The kahakō is a stress mark (macron) that can appear over vowels only and serve to make the vowel sound slightly longer. The vowels ā, ē, ī, ō, and ū sound just like their non-stress Hawaiian vowels with the exception that the sound is held slightly longer. Missing the ʻokina or kahakō can greatly change not only the how a word sounds, but also its basic meaning. A popular example of how an ʻokina and a kahakō can change the meaning of a word is "pau":

- pau = finished, ended, all done
- paʻu = soot, smudge, ink powder
- paʻū = moist, damp
- pāʻū = skirt

***Unit Names***

| | | |
|---|---|---|
| Punamanō | *(POO-nah mah-NOHH)* | meaning: shark spring |
| Kiʻi | *(KEE-ee)* | meaning: image |

## ***Waterbirds***

**Ae‘o** (EYE oh)

**Hawaiian Stilt** *Himantopus mexicanus knudseni*

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Indigenous

*Laura Beauregard*

**‘Alae ke‘oke‘o** (ah-lye KAY oh KAY oh)

**Hawaiian Coot** *Fulica alai*

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic

*Laura Beauregard*

**‘Alae ‘Ula** (ah-lye OO-lah)

**Hawaiian Moorhen** *Gallinula chloropus sandvicensis*

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Indigenous

*USFWS*

**‘Auku‘u** (ow-KOO oo)

**Black-crowned Night Heron** *Nycticorax nycticorax hoactli*

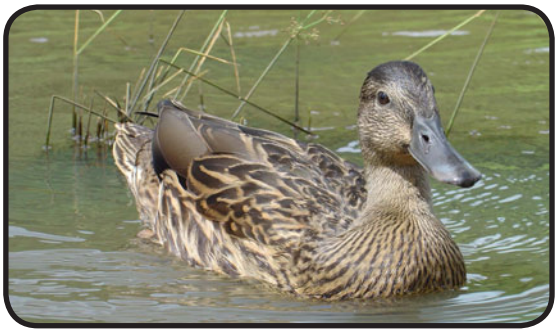
SPECIES STATUS:
State recognized as Indigenous

*Laura Beauregard*

**Koloa Maoli** (ko-LOWah MAOW-lee)

**Hawaiian Duck** *Anas wyvilliana*

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic



*Brenda Zaun*

## ***Migrant Shorebirds***

**ʻAkekeke** (ah-kay-KAY-kay)

**Ruddy Turnstone** *Arenaria interpres*

SPECIES STATUS:
State recognized as Indigenous
U.S. Shorebird Conservation Plan - High Concern

*Michael Walther*

**Hunakai** (hoo-nah-KYE)

**Sanderling** *Calidris alba*

SPECIES STATUS:
State recognized as Indigenous
*Hunakai means "sea foam." Their habit of running along the receding waves on the shore in search of small sand crabs apparently reminded early Hawaiians of the sea foam or hunakai left behind by the waves. It shares the name with a coastal plant.*

*Michael Walther*

**Kioea** (kee-oh-AY-ah)

**Bristle-thighed Curlew** *Numenius tahitiensis*

SPECIES STATUS:
State recognized as Indigenous
IUCN Red List Ranking-Vulnerable

*Laura Beauregard*

**Kōlea** (KOHH-lay-ah)

**Pacific Golden Plover** *Pluvialis fulva*

SPECIES STATUS:
State recognized as Indigenous
U.S. Shorebird Conservation Plan - High Concern

*Michael Walther*

**ʻŪlili** (OOO-lee-lee)

**Wandering Tattler** *Heteroscelus incanus*

SPECIES STATUS:
State recognized as Indigenous
U.S. Shorebird Conservation Plan - Moderate Concern

*Michael Walther*

## ***Seabirds***

### **ʻKaʻupu (kah OO-poo)**

**Black-footed Albatross** *Phoebastria nigripes*

SPECIES STATUS:
State listed as Threatened
State recognized as Indigenous
IUCN Red List Ranking - Endangered

*David Leonard*

### **Mōlī** (MOE-lee)

**Laysan Albatross** *Phoebastria immutabilis*

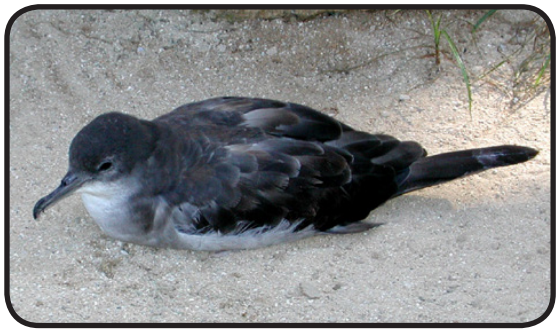
SPECIES STATUS:
State recognized as Indigenous
North American Waterbird Conservation Plan - High concern

*Linday Young*

### **ʻUaʻu Kani** (OO-ah oo KAH-nee)

**Wedge-tailed Shearwater** *Puffinus pacificus*

SPECIES STATUS:
State recognized as Indigenous



*NPS*

### **Koaʻeʻula** (KOH-ah ay OO-lah)

**Red-tailed Tropicbird** *Phaethon rubricauda*

SPECIES STATUS:
State recognized as Indigenous
North American Waterbird Conservation Plan - Moderate concern

*Laura Beauregard*

### **ʻĀ** (AHH)

**Red-footed Booby** *Sula sula*

SPECIES STATUS:
State recognized as Indigenous

*Laura Beauregard*

## ***Native Animals***

**Honu (**HO-noo)

**Hawaiian Green Turtle** *Chelonia mydas*

SPECIES STATUS:
Federally listed as Threatened
State recognized as Indigenous
IUCN Red List Ranking - Endangered

*Laura Beauregard*

**ʻĪlio-holo-i-ka-uaua** (EEE-lee-oh HO-loh EE kah OO-ah OO-ah)

**Hawaiian Monk Seal** *Monachus schauinslandi*

SPECIES STATUS:
Federally listed as Endangered

*NOAA*

**ʻŌpaeʻula** (OHH-pye OO-lah)

**Hawaiian Red Shrimp** *Halocaridina rubra*

SPECIES STATUS:
State recognized as Indigenous

*Mike Yamamoto*

**ʻŌpeʻapeʻa** (OHH-pay ah-PAY ah)

**Hawaiian Hoary Bat** *Lasiurus cinereus semotus*

SPECIES STATUS:
Federally listed as Endangered

*Tom DeGuiar*

**Pueo** (poo-AY-oh)

**Hawaiian Short-eared Owl** *Asio flammeus sandwichensis*

SPECIES STATUS:
State recognized as Endangered on Oʻahu
State recognized as Endemic

*Tom Dove*

## ***Native Plants - Herbs***

**ʻĀkulikuli** (AAH-koo-lee-KOO-lee)

**Sea Purslane** *Sesuvium portulacastrum*

SPECIES STATUS:
State recognized as Indigenous

*Laura Beauregard*

**ʻĀkiʻaki** (AH-kee AH-kee)

**Beach Dropseed** *Sporobolus virginicus*

SPECIES STATUS:
State recognized as Endemic

*Laura Beauregard*

**Pōhuehue** (POHH-hoo-ay-HOO-ay)

**Railroad Vine, Beach Morning Glory** *Ipomoea pescaprae*

SPECIES STATUS:
State recognized as Indigenous

*Laura Beauregard*

**ʻIlima** (ee-LEE-mah)

**Yellow Ilima** *Sida Fallax*

SPECIES STATUS:
State recognized as Indigenous

*Laura Beauregard*

**Pōhinahina** (POHH-hee-nah HEE-nah)

**Beach Vitex** *Vitex rotundifolia*

SPECIES STATUS:
State recognized as Indigenous

*Laura Beauregard*

## ***Native Plants - Shrubs & Trees***

**Hala** (HAH-lah)

**Beach Vitex** *Pandanus tectorius*

SPECIES STATUS:
State recognized as Indigenous

*Laura Beauregard*

**‘Iliahiao‘e** (ee-lee-AH-hee-ah-LOW ay)

**Coastal Sandalwood** *Santalum ellipticum*

SPECIES STATUS:
State recognized as Endemic

*Forest & Kim Starr*

**Naio** (NYE-oh)

**False Sandalwood** *Myoporum sandwicense*

SPECIES STATUS:
State recognized as Indigenous

*Forest & Kim Starr*

**Naupaka Kahakai** (now-PAH-kah kah-HAH-kye)

**Beach Naupaka** *Scaevola taccada*

SPECIES STATUS:
State recognized as Indigenous

*Laura Beauregard*

**Wiliwili** (VEE-lee-VEE-lee)

**Hawaiian Coral Tree** *Erythrina sandwicensis*

SPECIES STATUS:
State recognized as Endemic

*DOFAW*

***Ka„āina me ke wai, ka nohona i ka nāhelehele laha „oke o Hawai„i***


# Chapter 1. Introduction

James Campbell National Wildlife Refuge (NWR or Refuge) is located in the Kahuku ahupua„a of the Ko„olauloa district on the north shore of O„ahu. Drawn to the area by the rich ocean waters and fertile lands dotted with natural springs, Native Hawaiians settled in Ko„olauloa around 1100 CE. One of the few scattered remnants of natural wetlands that still exist on O„ahu, the Refuge was established in 1976 for the purpose of providing habitat for endangered Hawaiian waterbirds. Expansion was authorized in 2005 for the purposes of providing additional habitat for endangered waterbirds, migratory shorebirds, waterfowl, seabirds, endangered and native plant species, endangered „īlio-holo-i- ka-uaua (Hawaiian monk seal), and threatened honu (Hawaiian green turtle); providing increased wildlife-dependent public uses; and assisting with flood damage reduction in the local area.

IMPORTANT NOTE TO READERS

The U.S. Fish and Wildlife Service currently has an agreement with the James Campbell Company to purchase land from the company to expand the James Campbell NWR. At the time of this draft Comprehensive Conservation Plan (CCP) for the Refuge, the process to complete the purchase of these lands is still ongoing. Because this plan is intended to cover a 15-year time period and the final purchase of these lands is anticipated in 2011 or 2012, the expansion lands have been incorporated into this plan. All alternatives and strategies for Refuge management described in this plan related to the expansion lands are contingent upon the successful completion of the purchase of those lands and construction of new facilities.

## 1.1 Proposed Action

We, the U.S. Fish and Wildlife Service (Service), manage the James Campbell NWR as part of the National Wildlife Refuge System (Refuge System). We propose to adopt and implement a Comprehensive Conservation Plan (CCP) for the Refuge. This document is the Refuge‟s Draft Comprehensive Conservation Plan and Environmental Assessment (CCP/EA) and includes all lands within the approved boundary. A CCP sets forth management guidance for a refuge for a period of 15 years, as required by the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd et seq.) as amended by the National Wildlife Refuge System Improvement Act of 1997 (Pub. Law 105-57) (Administration Act). The Administration Act requires CCPs to identify and describe:

- The purposes of the refuge;
- The fish, wildlife, and plant populations, their habitats, and the archaeological and cultural values found on the refuge;
- Significant problems that may adversely affect wildlife populations and habitats and ways to correct or mitigate those problems;
- Areas suitable for administrative sites or visitor facilities; and
- Opportunities for fish and wildlife-dependent recreation.

The Refuge System planning policy (Service Manual 602 FW 3, June 21, 2000) states that the purpose of CCPs is to: “describe the desired future conditions of a refuge and provide long-range guidance and management direction to achieve refuge purposes; help fulfill the National Wildlife Refuge System mission; maintain and, where appropriate, restore the ecological integrity of each refuge and the Refuge System; . . . and meet other mandates.”

The Service has developed and examined alternatives for managing James Campbell NWR through the CCP planning process. The various alternatives address the major issues and relevant mandates identified in the CCP process and are consistent with principles of sound fish and wildlife management. The Service has consolidated management options into three alternatives for James Campbell NWR and has identified Alternative C as the preferred alternative. The draft preferred alternative appears to represent the best balanced approach for achieving the Refuge‟s purposes, vision, and goals; contributing to the Refuge System mission; and addressing the relevant issues and mandates consistent with sound principles of fish and wildlife management. However, the preferred alternative may be modified between the draft and final document depending upon comments received from the public or other agencies and organizations. The Regional Director for the Service‟s Pacific Region will be the final decisionmaker regarding the alternative that will be adopted for implementation. For details on the specific components and actions comprising the range of alternatives, see Chapter 2.

## 1.2 Purpose and Need for the CCP

The purpose of the CCP is to provide the Refuge System, the Service, partners, and citizens with a management plan for improving fish and wildlife habitat conditions and infrastructure for wildlife, staff, and refuge visitors for 15 years. An approved CCP will help ensure that the Service manages James Campbell NWR to achieve its purpose, vision, goals, and objectives, and to help fulfill the Refuge System mission. Another purpose of the CCP is to provide reasonable, scientifically grounded guidance for improving the Refuge‟s subterranean, upland, coastal, surface water and wetland habitats for the long-term conservation of native plants and animals. The CCP will identify

appropriate actions for protecting and sustaining the cultural and biological features of coastal communities; endangered, threatened, or rare species populations and habitats; and migratory shorebirds. The CCP will also evaluate priority wildlife-dependent recreational uses on the Refuge.

The CCP is needed for a variety of reasons. Primary among these is the need to improve degraded habitat conditions by removing pest plants and animals, such as kiawe shrubs, rats, and mongooses. There is also a need to address James Campbell NWR‟s contributions to aid in the recovery of endangered species, and assess and possibly mitigate potential impacts of global climate change to Refuge resources. The Service should continue to effectively work with current partners such as the State of Hawai‚i and National Oceanic and Atmospheric Administration (NOAA), as well as seek new partnerships to restore habitats, improve environmental education (EE) and interpretive opportunities and volunteer programs, and recover endangered species populations.

## 1.3 Content and Scope of the CCP

This CCP provides guidance for managing Refuge habitats and wildlife, and administering public uses on Refuge lands. The James Campbell NWR Draft CCP/EA is intended to comply with the requirements set forth in the Administration Act and the National Environmental Policy Act (NEPA). Information included in the CCP includes:

- An overall vision for the Refuge, its establishment history and purpose, and its role in the local ecosystem (Chapter 1);
- Management alternatives, goals, and objectives for specific conservation targets and visitor programs, as well as strategies for achieving the objectives (Chapter 2);
- A description of the Refuge‟s physical environment (Chapter 3);
- A description of conservation targets, condition, and trends on the Refuge and within the local ecosystem; a presentation of the key desired ecological conditions for sustaining the targets; and a short analysis of the threats to each conservation target (Chapter 4);
- An overview of the Refuge‟s visitor programs and facilities, a list of desired future conditions for each program, and other management considerations (Chapter 5);
- An analysis of the environmental effects associated with implementing the various management actions prescribed under the alternatives described in Chapter 2 (Chapter 6);
- A comprehensive list of species known to occur on the Refuge or mentioned in the CCP/EA (Appendix A);
- Evaluations of existing and proposed appropriate public and economic uses for compatibility with the Refuge‟s purposes (Appendix B);
- An Implementation Plan needed to support the alternatives considered (Appendix C);
- Wilderness Review (Appendix D);
- Integrated Pest Management (Appendix E); and
- Literature Cited (Appendix F).

# 1.4 Planning and Management Guidance

The Service, an agency within the Department of the Interior, is the principal Federal agency responsible for conserving, protecting, and enhancing fish, wildlife, and plants and their habitats. Refuge management is guided by Federal laws, Executive orders, Service policies, and international treaties. Fundamental guidelines are found in the mission and goals of the Refuge System and the designated purposes of the Refuge as described in establishing legislation, Executive orders, or other documents establishing, authorizing, or expanding a refuge.

Key concepts and guidance of the Refuge System derive from the Administration Act, the Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, Title 50 of the Code of Federal Regulations (CFR), and the Fish and Wildlife Service Manual. The Administration Act is implemented through regulations covering the Refuge System, published in Title 50, subchapter C of the Code of Federal Regulations. These regulations govern general administration of units of the Refuge System.

## 1.4.1 U.S. Fish and Wildlife Service Mission

The mission of the Service is "working with others, to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people." National natural resources entrusted to the Service for conservation and protection include migratory birds, endangered and threatened species, interjurisdictional fish, wetlands, and certain marine mammals. The Service also manages national fish hatcheries, enforces Federal wildlife laws and international treaties on importing and exporting wildlife, assists with State and Territorial fish and wildlife programs, and helps other countries develop wildlife conservation programs.

## 1.4.2 National Wildlife Refuge System

The Refuge System is the world"s largest network of public lands and waters set aside specifically for conserving wildlife and protecting ecosystems. From its inception in 1903, the Refuge System has grown to encompass over 550 national wildlife refuges in all 50 States, and waterfowl production areas in 10 States, covering more than 150 million acres of public lands and waters. More than 40 million visitors annually fish, hunt, observe and photograph wildlife, or participate in EE and interpretive activities on national wildlife refuges.

## 1.4.3 National Wildlife Refuge System Mission and Goals

The mission of the Refuge System is "to administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (Administration Act). The goals of the Refuge System, as articulated in the Mission, Goals, and Purposes policy (601 FW1), follow:

- Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered;

- Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges;
- Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts;
- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and EE and interpretation); and
- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

### 1.4.4 National Wildlife Refuge System Administration Act of 1966

Of all the laws governing activities on national wildlife refuges, the Administration Act exerts the greatest influence. The Administration Act was amended by the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act). The Improvement Act included a unifying mission for all national wildlife refuges, a new process for determining compatible uses on refuges, and a requirement that each refuge will be managed under a CCP developed in an open public process. The Administration Act states that the Secretary shall provide for the conservation of fish, wildlife, plants, and their habitats within the Refuge System, and ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained. House Report 105-106 accompanying the Improvement Act states "…the fundamental mission of our System is wildlife conservation: wildlife and wildlife conservation must come first." Biological integrity, diversity, and environmental health are critical components of wildlife conservation. As later made clear in the Biological Integrity, Diversity, and Environmental Health policy, "the highest measure of biological integrity, diversity, and environmental health is viewed as those intact and self-sustaining habitats and wildlife populations that existed during historic conditions."

Each refuge must be managed to fulfill the Refuge System mission as well as the specific purposes for which it was established. The Administration Act requires the Service to monitor the status and trends of fish, wildlife, and plants on every refuge. Additionally, six wildlife-dependent recreational uses are granted special consideration in the planning, management, establishment, and expansion of units of the Refuge System: hunting, fishing, wildlife observation and photography, and EE and interpretation. When determined compatible on a refuge-specific basis, these six uses assume priority status among all public uses of the refuge in question. The overarching goal is to enhance wildlife-dependent recreation opportunities and access to quality visitor experiences on refuges, while managing refuges to conserve fish, wildlife, plants, and their habitats. The Service is directed to make extra efforts to facilitate wildlife-dependent visitor opportunities.

*Ae'o chick tests the water Laura Beauregard/USFWS*

When preparing a CCP, refuge managers must re-evaluate all general public, recreational, and economic uses proposed or occurring on a refuge for appropriateness and compatibility. No refuge use may be allowed or continued unless it is determined to be appropriate and compatible. Generally, an appropriate use is one that contributes to fulfilling refuge purposes, the Refuge System mission, or goals and objectives described in a refuge management plan. A compatible use is defined as a use that, in the sound professional judgment of the refuge manager, will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge. Updated Appropriate Use Findings and Compatibility Determinations for existing and proposed uses for James Campbell NWR are in Appendix B.

The Administration Act also requires that, in addition to formally established guidance, the CCP must be developed with the participation of the public. Public comments play a role in identifying issues, guiding alternatives considered during development of the CCP, and selecting a preferred alternative. It is Service policy to develop CCPs in an open public process; the agency is committed to securing public input throughout the process.

## 1.5 Relationship to Previous and Future Refuge Plans

Planning has been a part of refuge operations since establishing refuges began. However, not all plans were completed in a comprehensive fashion or with public participation considered adequate today.

### 1.5.1 Previous Plans

Previous plans that provided guidance for managing James Campbell NWR include:

- Master Plan for the Hawaiian Wetlands National Wildlife Refuge Complex (USFWS 1985); and
- Draft Revised Recovery Plan for Hawaiian Waterbirds, Second Draft of Second Revision (USFWS 2005).

### 1.5.2 Future Planning

The CCP will be revised every 15 years or earlier if environmental conditions significantly change or monitoring and evaluation determine that changes are needed to achieve refuge purposes, vision, goals, or objectives. The CCP provides guidance in the form of goals, objectives, and strategies for refuge program areas but may lack some of the specifics needed for implementation. Stepdown management plans will therefore be developed for individual program areas, as needed, following completion of the CCP. Stepdown plans require appropriate NEPA compliance. Several stepdown plans (including the Visitor Services Plan, Transportation Plan, Land Protection Plan, and Inventory and Monitoring Plan) are appropriate to develop and/or update following CCP completion. All of the stepdown plans should be based on the management goals, objectives, and strategies outlined in the CCP. A list of proposed stepdown plans is available in Appendix C.

# 1.6 Refuge Establishment and Purposes

## 1.6.1 General

The Administration Act directs the Service to manage each refuge to fulfill the mission of the Refuge System, as well as the specific purposes for which that refuge was established. Refuge purposes are the driving force in developing refuge vision statements, goals, objectives, and strategies in the CCP. Refuge purposes are also critical to determining the compatibility of all existing and proposed refuge uses. Lands within the Refuge System are acquired and managed under a variety of legislative acts, administrative orders, and legal authorities. The official purpose or purposes for a refuge are specified in or derived from the law, Presidential proclamation, Executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit. The Service defines the purpose of a refuge when it is established or when new land is added to an existing refuge. When an addition to a refuge is acquired under an authority different from the authority used to establish the original refuge, the addition takes on the purposes of the original refuge, but the original refuge does not take on the purposes of the addition. Refuge managers must consider all of the purposes. However, purposes dealing with the conservation, management, and restoration of fish, wildlife, and plants and their habitats take precedence over other purposes in the management and administration of a refuge.

## 1.6.2 James Campbell NWR Establishment

The earliest document identifying areas for protection and management within the James Campbell NWR boundary is Hawai„i's Endangered Waterbirds (U.S. Bureau of Sport Fisheries and Wildlife 1970*). It identified three small ponds, Ki„i, Punamanō, and Punaho„olapa, as well as adjacent marshes, as being valuable to waterbirds. Shortly thereafter, the area was identified and proposed for acquisition as a Refuge with the purpose: "To preserve habitat vital to the rare and endangered species ae„o (Hawaiian stilt), „alae ke„oke„o (Hawaiian coot), and provide habitat for other shorebirds and waterfowl on the Island of O„ahu" (U.S. Bureau of Sport Fisheries and Wildlife 1971*).

*'Alae 'ula Mike Silbernagle/USFWS*

The Refuge was established in 1976 with approximately 150 acres under a $1 a year lease with the Estate of James Campbell. Over the last several years, through the leadership of Senator Daniel Inouye and Hawai„i"s congressional delegation, Congress appropriated a total of $22 million to acquire and expand the Refuge to a total of approximately 1,100 acres.

* The Fish and Wildlife Act of 1956 created the U. S. Fish and Wildlife Service and established two bureaus, Sport Fish and Wildlife and Commercial Fisheries. In 1970, the Bureau of Commercial Fisheries was transferred to the Department of Commerce and renamed the National Marine Fisheries Service. The remaining Bureau of Sport Fisheries and Wildlife became today"s U.S. Fish and Wildlife Service.

In 2005, Public Law 109-225 authorized expansion of the James Campbell NWR and identified management focus areas for the Refuge expansion lands as to:

- Promote the recovery of four species of endangered Hawaiian waterbirds;
- Permanently protect endangered species habitat;
- Improve management of the Refuge;
- Protect coastal dunes, coastal wetlands, and coastal strand habitats that promote biological diversity, including the four species of endangered Hawaiian waterbirds, migratory shorebirds, waterfowl, seabirds, endangered and native plant species, endangered Hawaiian monk seals, and green turtles;
- Provide increased opportunities for wildlife-dependent public uses, including wildlife observation, photography, and EE and interpretation;
- Create a single, large, manageable, and ecologically-intact unit that includes sufficient buffer land to reduce impacts on the Refuge; and
- Reduce flood damage following heavy rainfall to residences, businesses, and public buildings in the town of Kahuku.

### 1.6.3 James Campbell NWR Purpose

The official purpose of the James Campbell NWR is "…to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...".

## 1.7 Refuge Goals

Goals and objectives are the unifying elements of successful refuge management. They identify and focus management priorities, resolve issues, and link to refuge purposes, Service policy, and the Refuge System mission. A CCP describes management actions that help bring a refuge closer to its vision. A vision broadly reflects refuge purposes, Refuge System mission and goals, other statutory requirements, and larger-scale plans as appropriate. Visitor services and wildlife/habitat management goals then define general targets in support of the vision, followed by objectives that direct efforts into incremental and measurable steps toward achieving those goals. Finally, strategies identify specific tools and actions to accomplish objectives. The James Campbell NWR vision statement is found on the inside front cover of this document. The following are our goals; their order does not imply any priority in this CCP.

**Nā Pahuhopu o ka Pu‘uhonua**

1. Kīa ,,i a mālama i nā ,,āina pālielie no ka holomua ,,ana o ka nohona a me ke ola ,,ana o na manu wai a me nā manu kai i holo mua ho,,i ko lākou ola ,,ana.

2. Ho,,,,opa,,a inā lāwena ,,āina no ka hui ka Pu,,uhonua ,,o James Campbell e hiki ai ke ho,, ,,onui aku i ia ,,āina no ka ho,,iho ,, ,,i hou, kīa ,,i a e mālama ho ,,i i nā kaianoho a e like ho,,i me ka makemake o ka hui Ho,,omalu holoholona a e loa ,,a pu ho ,,i nā makemake a nā limahana ho ,,omalu holoholona kekahi.

3. Ho,,iho,,i hou a kīa ,,i i nā lihi kahakai,,a me nā kaianoho pu,,e one a e malama ho ,,i i wahi noho maluhia no nā ,,ilio holo i ka uaua ,,ane make loa, a me nā Honu a e mālama pū hoi i wahi noho no nā manu kai, nā manu lihikai, a me manu ne ,,ekau.

4. E ,,ohi,,ohi ho,,i i nā mana ,,o ,,epekema e pili ana i ia wahi no ka ho ,,omākaukau ,,ana a e ho,,okupu ho,,i i ha,,awina e holomua ai nā mana,,o mālama ,,āina a e kōkua pū ho,,i i ka pahu hopu 1 a me ka pahu hopu 3.

5. E ho,,omākaukau ho,,i i kumuwaiwai no ka wehewehe ,,ana a e ho,,omaopopo pū ho ,,i i nā kānaka e pili ana i ka waiwai o ia ,, āina, nā pilina mālama ,,āina, a me nā mo‘‘aukala e pili ana ho,,i no ia wahi ,,āina ho,,omalu holoholona lōhiu Pu,,uhonua ,,o James Campbell.

6. E mālama ho,,i i nā mo,,aukala a me nā mo,,omeheu ,,o ia wahi no ka pono o nā kānaka mai kēia au a ia au a,,e e hiki mai ana.

7. E kōkua ho,,i ma ke kōkua ,,ana e ho,,emi i ka nui pilikia i ke kaiaulu ke loa,,a mai ka wai hālana a i ,,ole kekahi ino ua nui paha.

**Refuge Goals**

1. Protect and manage seasonal wetland habitats to meet the life-history needs of endangered waterbirds to promote their recovery.

2. Complete acquisition of the James Campbell National Wildlife Refuge expansion to restore, protect, and manage habitats according to Refuge purposes and to meet Refuge staff facility needs.

3. Restore and protect coastal strand/dune and upland scrub/shrub habitats to provide safe refuge for endangered ,,ilio-holo-i-ka-uaua and threatened honu, as well as provide habitat for seabirds, shorebirds, and migratory birds.

4. Collect scientific information necessary to guide management decisions in support of Goals 1-3.

5. Provide wildlife-dependent public use and educational opportunities to enrich public appreciation of the natural resources of James Campbell NWR and the National Wildlife Refuge System.

6. Protect historic and cultural resources for the benefit of present and future generations.

7. Assist partner agencies and the local community with planning and implementation of flood damage control measures for the Town of Kahuku.

# 1.8 Relationship to Ecosystem Planning Efforts

When developing a CCP, the Service considers the goals and objectives of existing national, regional, and ecosystem plans; State/Territorial fish and wildlife conservation plans; and other landscape-scale plans developed for the same watershed or ecosystem in which the refuge is located. To the extent possible, the CCP is expected to be consistent with these existing plans and assist in meeting their conservation goals and objectives (Part 602 FW 3.3). This section summarizes some of the key plans that were reviewed by members of the planning team during CCP development.

***Hawai„i"s Comprehensive Wildlife Conservation Strategy,*** 2005. With passage of the Commerce, Justice, and State Appropriations Act of 2001, Congress mandated each State and Territory to develop its own comprehensive strategy. *Hawai'i's Comprehensive Wildlife Conservation Strategy* thoroughly reviews the status of the full range of the State"s native terrestrial and aquatic species, over 10,000 of which are found nowhere else on Earth. Hawai„i"s Species of Greatest Conservation Need include all native terrestrial animals, all endemic aquatic animals, additional indigenous aquatic animals identified as in need of conservation attention, a range of native plants identified as in need of conservation attention, and all identified endemic algae. This list includes: terrestrial mammal (1), birds (77), terrestrial invertebrates (~5,000), freshwater fishes (5), freshwater invertebrates (12), anchialine pond-associated fauna (20), marine mammals (26), marine reptiles (6), marine fishes (154), marine invertebrates (197), and flora (over 600). Details on all the listed wildlife taxa are provided in fact sheets that contain information for taxa, closely related groups of species, and species facing similar threats.

***Draft Revised Recovery Plan for Hawaiian Waterbirds, Second Draft of Second Revision,*** May 2005. The ultimate goal of the recovery program is to restore and maintain multiple self-sustaining populations of Hawaiian waterbirds within their historic ranges. The recovery of the endangered waterbirds focuses on the following objectives:

- Increasing population numbers to Statewide baseline levels (consistently stable or increasing with a minimum of 2,000 birds for each species);
- Establishing multiple, self-sustaining breeding populations throughout each species" historic range;
- Establishing and protecting a network of both core and supporting wetlands that are managed as habitat suitable for waterbirds, including the maintenance of appropriate hydrological conditions and control of invasive nonnative plants;
- For all four species, eliminating or controlling the threats posed by introduced predators, avian diseases, and contaminants; and
- For the koloa maoli (Hawaiian duck), removing the threat of hybridization with feral mallards.

***U.S. Pacific Islands Regional Shorebird Conservation Plan,*** 2004. Conservation and restoration of shorebird habitats is essential for the protection of endangered and declining shorebird populations. Wetlands, beach strand, coastal forests, and mangrove habitats are particularly vulnerable on Pacific islands due to increasing development pressures and already limited acreage. Monitoring and research needs include assessment of population sizes and trends; assessment of the timing and abundance of birds at key wintering and migration stopover sites; assessment of habitat use and requirements at wintering and migration areas; exploration of the geographic linkages between wintering, stopover, and breeding areas; and evaluation of habitat restoration and management

techniques to meet the needs of resident and migratory species. Education and public outreach are critical components of this plan. Resource management agencies of Federal, Territorial, Commonwealth, and State governments will need to work together with military agencies, nongovernmental organizations, and the scientific community. On a larger scale, coordination at the international level will be key to the conservation of vulnerable species, both migratory and resident.

***Koʻolau Loa Sustainable Communities Plan,*** 1999. This update reaffirms Koʻolau Loaʻs role in Oʻahuʻs development pattern as intended in the General Plan policies by establishing principles for future land use and development:

- Recognize traditional ahupuaʻa divisions and distinctions and incorporate the ahupuaʻa concept as the primary basis for land use planning in Koʻolau Loa;
- Maintain and, where possible, expand critical open space areas and shoreline views between the existing pattern of community development so as to preserve a separation between the natural and built environment within each ahupuaʻa;
- Preserve the existing strong relationship between the natural landscape of the mountains to the ocean, and the manmade landscape of agricultural fields and small rural communities;
- Promote diversified agriculture and aquaculture on existing agricultural lands in accordance with the General Plan policy to support agricultural diversification in all rural areas on Oʻahu;
- Preserve continuous coastal views and scenic views of ridges, valley slopes, and prominent land features;
- Provide for new employment-based development that will offer quality jobs and be compatible with the existing communitiesʻ rural fabric and the natural environment;
- Limit future resort development to the existing zoned lands in secondary resort areas at Kahuku Point-Kawela Bay area and Lāʻie; and
- Support and encourage improvements at existing educational and recreational facilities.

The vision for Koʻolau Loa seeks to preserve the regionʻs rural character and its natural, cultural, scenic, and agricultural resources. The region will remain country, characterized by small towns and villages with distinct identities that exist in harmony with the natural settings of mountain ridges and winding coastline.

***Recovery Plan for the Hawaiian Monk Seal (Monachus schauinslandi),*** 2007. The ʻīlio-holo-i-ka-uaua has the distinction of being the only endangered marine mammal whose entire species range – historic and current – lies within the United States. The majority of the population of seals now lies in the Northwestern Hawaiian Islands (NWHI) with six main breeding subpopulations. The species is also found in lower numbers in the main Hawaiian Islands where the population size and range both appear to be expanding. The main terrestrial habitat requirements include haul-out areas for pupping, nursing, molting, and resting. These are primarily sandy beaches, but virtually all substrates are used at various islands. The goal of this revised recovery plan is to assure the long-term viability of the ʻīlio-holo-i-ka-uaua in the wild, allowing initially for reclassification to threatened status and, ultimately, removal from the List of Endangered and Threatened Wildlife.

***Recovery Plan for U.S. Pacific Populations of the Green Turtle (Chelonia mydas),*** 1997. The honu is listed as threatened throughout its Pacific Range, except for the endangered population nesting on the Pacific coast of Mexico, which is covered under the Recovery Plan for the East Pacific green turtle. By far, the most serious threat to these honu is from direct take of turtles and eggs, both within

U.S. jurisdiction and on shared stocks that are killed when they migrate out of U.S. jurisdiction. In Hawai,,i, honu populations appear to have a somewhat less dire status, probably due to effective protection at the primary nesting areas of the NWHI and better enforcement of regulations prohibiting take of the species. However, an increase in the incidence of the tumorous disease, fibropapillomatosis (FP), in the Hawaiian honu threatens to eliminate improvements in the status of the stock. Another serious threat to honu populations throughout the Pacific is associated with increasing human populations and development. In particular, human development is having an increasingly serious impact on nesting beaches.

# 1.9 Planning and Issue Identification

## 1.9.1 Issues to be Addressed in the Draft CCP

The following issues are being addressed in the planning process:

***Wildlife and Habitat Resources***: Endangered waterbirds and plants are the primary management focus, but management also considers and includes endangered ,ılio-holo-i-ka-uaua, threatened honu, migratory shorebirds, waterfowl, seabirds, and native plant species.

***Facilities and Maintenance***: Facilities maintenance includes vehicles; heavy equipment; fencing; weather stations; ditches, dikes, and impoundments; water control structures, wells and pumps. Due to the coastal environmental conditions (e.g., constant wind containing salt spray, precipitation, warm temperatures, and high humidity), degradation of equipment and facilities is accelerated and often exceeds normally acceptable Mainland standards for maintenance costs and schedules. The Refuge office is in Hale,,iwa at a General Services Administration rental site roughly 20 miles from the Refuge, which contributes to transportation costs.

***Visitor Services Activities***: Environmental education, interpretation, and wildlife observation are currently offered on a limited basis through special use permits and/or volunteer docent-led tours. The presence of nesting endangered species throughout much of the calendar year restricts public access. Sensitive areas will be closed to the public as new lands are acquired.

***Law Enforcement***: Refuge officers are responsible for upholding Federal laws and regulations that protect natural resources, the public, and employees. The sole Zone Officer is stationed in Honolulu and has responsibilities that extend to all of the Hawaiian and Pacific Islands refuges.

## 1.9.2 Issues Outside the Scope of the Draft CCP

***Neighboring Development:*** New construction proposed or associated with Turtle Bay Resort or Kahuku First Wind turbine project adjacent to the Refuge is outside our jurisdiction. Cumulative effects to air quality have been considered in the EA.

***Fishing Regulations:*** State fishing regulations and access to the ocean (via the State"s public beach corridor on private lands) are outside of the Refuge"s jurisdiction, and will not be addressed in the CCP.

# Chapter 2. Alternatives, Goals, Objectives, and Strategies

## 2.1 Introduction

The Service proposes to adopt and implement a 15-year CCP to guide the management and administration of the Refuge throughout the life of the CCP. This chapter presents and compares a range of reasonable alternatives for this proposed action, including a preferred alternative. It also includes information on the development of the alternatives, alternatives or components considered but dropped from further analysis, and elements or actions common to all alternatives. Table 1 summarizes, compares, and contrasts the alternatives.

## 2.2 Development of Alternatives

Initial alternatives were developed between fall 2009 and spring 2010 after initial scoping and public involvement. These alternatives are: A. Continue Current Management (no action); B. Partial Restoration and Management of Refuge Expansion Lands; and C. Full Restoration and Management of Refuge Expansion Lands (preferred alternative). The three alternatives are described in detail in Section 2.5. Under all alternatives, the wetlands at the Ki„i and Punamanō units are managed as core management areas as identified in the Recovery Plan for Hawaiian Waterbirds (USFWS 2005).

## 2.3 Alternative Components Not Considered for Detailed Analysis

During scoping, public involvement, and the development of the objectives and strategies that make up each alternative, a variety of ideas and solutions were presented, explored, and debated. The following alternative components were considered but not selected for further analysis in this Draft CCP/EA for the reason(s) described.

### 2.3.1 Kahuku Airfield Restoration for Private Aircraft

*Eroded runway Laura Beauregard/ USFWS*

We received a suggestion that the Service should preserve and reopen an old asphalt runway located in the approved acquisition area. The commenter recommended the runway be made available for: 1) an emergency landing site; 2) an auxiliary landing field for short-field practice; and 3) a recreation site for picnicking (accessible by air only).

Under Federal regulations at 50 CFR 27.34, aircraft are prohibited from operating over national wildlife refuges at altitudes that result in harassment of wildlife and specifically prohibits unauthorized landings or take-offs. Refuge management plans

include removing existing encroaching pest vegetation on the runway and aprons of the runway to improve the site as potential seabird nesting habitat. The current remnant runway is frequently used by migratory birds, including kioea and kolea. Due to the designated wildlife purposes of the James Campbell NWR and planned habitat management on and around the runway to benefit birds, any request for authorized use of the runway would not be an appropriate use. As provided for in 50 CFR 27.34, emergency aircraft operations (i.e., emergency landings) are permitted.

### 2.3.2 Nonlethal Techniques to Remove Mammalian Predators

In accordance with policy 569 FW 1 (Integrated Pest Management), the Service chooses pest management methods by considering the following four factors (listed in their order of importance): human safety, environmental integrity, effectiveness, and cost. Live trapping and release of predators to other locations on O,,ahu or the State is not a sound biological strategy. Transporting predators and releasing them is not cost effective and has the potential to exacerbate resource management issues at other Federal, State, County, and private lands.

### 2.3.3 Public Trapping and Hunting to Remove Nonnative Mammalian Predators

These actions are dismissed from consideration for this CCP for the following reasons: potential disturbance to endangered species, lower effectiveness for removal of mammals, safety of and potential conflicts with other Refuge users, potential conflicts with Refuge staff implementing on-the-ground management actions, and the primary mammalian predators present (mongooses and rats) are generally not sought after species by the general hunting public. Pigs may occur on the Refuge in low numbers but will be controlled by staff or contractors to avoid the conflicts described above associated with public hunting.

## 2.4 Elements Common to All Alternatives

### 2.4.1 Implementation Subject to Funding Availability

Under each alternative, actions will be implemented over a period of 15 years as funding becomes available. Routine maintenance, repair, replacement, and improvement of existing facilities will continue, also dependent on funding.

### 2.4.2 Interagency Coordination and Collaboration

Ecosystem planning efforts discussed in Chapter 1, Section 1.8 involve collaboration among Federal, State, and local agencies toward mutual goals.

### 2.4.3 Threatened and Endangered Species Protection and Recovery

Protection of threatened and endangered species is common across all alternatives. It is Service policy to give priority consideration to the protection, enhancement, and recovery of these species on national wildlife refuges. The protection of federally listed species is mandated through the

Endangered Species Act of 1973. Section 7 of the Act, called "Interagency Cooperation," is the mechanism by which Federal agencies ensure the actions they take, including those they fund or authorize, do not jeopardize the existence of any listed species. To ensure adequate protection, the Refuge is required to review all activities, programs, and projects occurring on lands and waters of the Refuge to determine if they may affect listed species. If the determination is that an action may adversely affect an endangered species, then the Refuge conducts a formal review, known as a consultation, to identify those effects and means to mitigate those effects. Consultations are either completed or will be conducted, as needed, concurrent with development of the CCP. The resulting Section 7 documents will be included as an appendix in the final CCP.

### 2.4.4 Historic and Cultural Resource Protection

Cultural resources on Refuge lands receive protection and consideration in accordance with Federal cultural resources laws, Executive orders, and regulations, as well as policies and procedures established by the Department of the Interior and the Service. Although the presence of cultural resources, including historic properties, does not preclude a Federal activity, the Refuge will seek to identify and protect cultural resources whenever possible. Refuge management actions will support the State of Hawai„ï's vision statement "to promote the use and conservation of historic and cultural resources for the education, inspiration, pleasure and enrichment of the public in a spirit of stewardship and trusteeship for future generations" (State Historic Preservation Plan 2010-2014).

The Native American Graves Protection and Repatriation Act (NAGPRA) is a Federal law passed in 1990 that provides a process for museums and Federal agencies to return certain Native American cultural items -- human remains, funerary objects, sacred objects, or objects of cultural patrimony to lineal descendants, and culturally affiliated Indian tribes and Native Hawaiian organizations. A Native Hawaiian organization includes any organization that: (a) serves and represents the interests of Native Hawaiians, (b) has as a primary and stated purpose the provision of services to Native Hawaiians, and (c) has expertise in Native Hawaiian Affairs, and includes the Office of Hawaiian Affairs and Hui Malama I Na Kupuna „O Hawai„i Nei. The Department of the Interior has interpreted this definition to also include the Hawaiian island burial councils and various „ohana (extended families).

During early planning of any projects, the Refuge will provide the Service Regional Historic Preservation Officer (RHPO) a description and location of all projects and activities that affect ground and structures, including project requests from third parties. Information will also include any alternatives being considered. The RHPO will analyze these undertakings for potential to affect historic properties and enter into consultation with the State Historic Preservation Division and other parties as appropriate. The Refuge will also ask the public and local government officials to identify any cultural resource impact concerns. This notification is generally done in conjunction with the review required by NEPA or Service regulations on compatibility of uses.

## 2.4.5 Fire Management

The suppression of wildfires and the use of prescribed or controlled fire are a long-standing part of resource protection, public safety, and habitat management on national wildlife refuges. In 2003, a Fire Management Plan that incorporated NEPA compliance was approved for the Refuge and provides detailed guidance for the suppression and use of prescribed fire. That plan's actions and effects are incorporated through reference in this CCP/EA. The plan outlines wildfire response and prescribed fire objectives, strategies, responsibilities, equipment and staffing; burn units; implementation; monitoring; and evaluation. The complete Fire Management Plan is available at the Complex office in Hale,,iwa (USFWS 2003).

## 2.4.6 Participation in Planning and Review of Regional Development Activities

The Service will actively participate in planning and studies for ongoing and future industrial and urban development, contamination, and other potential concerns that may affect the Refuge‟s wildlife resources and habitats. The Service will continue to cultivate working relationships with pertinent State and Federal agencies to stay abreast of current and potential developments and will utilize effective outreach tools and technologies and EE as needed to raise awareness of the Refuge‟s resources. The Refuge will participate in local community initiatives to protect, steward, and enhance natural landscapes and wildlife habitat. We will continue to identify and pursue new opportunities for land acquisition that will benefit Refuge purposes.

## 2.4.7 Adaptive Management

Based upon 522 Departmental Manual (DM) 1 (Adaptive Management Implementation policy), Refuge staff shall utilize adaptive management for conserving, protecting, and, where appropriate, restoring lands and resources. Within 43 CFR 46.30, adaptive management is defined as a system of management practices based upon clearly identified outcomes, where monitoring evaluates whether management actions are achieving desired results (objectives). The recently published Department of the Interior (DOI) Adaptive Management Technical Guide also defines adaptive management as a decision process that “promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood.”

Adaptive management accounts for the fact that complete knowledge about fish, wildlife, plants, habitats, and the ecological processes supporting them may be lacking. The role of natural variability contributing to ecological resilience also is recognized as an important principle of adaptive management. It is not a “trial and error” process, but rather emphasizes learning while doing based upon available scientific information and best professional judgment considering site-specific biotic and abiotic factors on Refuge lands. Adaptive management results in effective monitoring and evaluation of the CCP.

Part of measuring the success of and adaptively managing the Refuge also includes the formal 15-year revision of the CCP. The revision will be initiated by the Service and will involve many of the same steps as this Draft CCP including comprehensive review of management plans and research; working closely with partners; and engaging the public.

## 2.4.8 Integrated Pest Management

In accordance with Department of the Interior policy 517 DM 1 and Service policy 569 FW 1, an integrated pest management (IPM) approach will be utilized, where practicable, to eradicate, control, or contain pest and invasive species (herein collectively referred to as pests) on Refuge lands. The IPM would involve using methods based upon effectiveness, cost, and minimal ecological disruption, which considers minimum potential effects to nontarget species and the refuge environment. Pesticides may be used where physical, cultural, and biological methods or combinations thereof are impractical or incapable of providing adequate control, eradication, or containment. If a pesticide would be needed on Refuge lands, the most specific (selective) chemical available for the target species would be used unless considerations of persistence or other environmental and/or biotic hazards would preclude it. In accordance with 517 DM 1, pesticide usage would be further restricted because only pesticides registered with the Environmental Protection Agency (EPA) in full compliance with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and as provided in regulations, orders, or permits issued by EPA may be applied on lands and waters under Refuge jurisdiction.

Environmental harm by pest species would refer to a biologically substantial decrease in environmental quality as indicated by a variety of potential factors, including declines in native species populations or communities, degraded habitat quality or long-term habitat loss, and/or altered ecological processes. Environmental harm may be a result of direct effects of pests on native species, including preying and feeding on them; causing or vectoring diseases; preventing them from reproducing or killing their young; outcompeting them for food, nutrients, light, nest sites, or other vital resources; or hybridizing with them so frequently that within a few generations, few if any truly native individuals remain. Environmental harm also can be the result of an indirect effect of pest species. For example, decreased waterfowl use may result from pest plant infestations reducing the availability and/or abundance of native wetland plants that provide forage during the winter.

Throughout the life of the CCP, most proposed pesticide uses on Refuge lands would be evaluated for potential effects to Refuge biological resources and environmental quality. Pesticide uses with appropriate and practical best management practices (BMPs) for habitat management as well as facilities maintenance would be approved for use on Refuge lands where there likely would be only minor, temporary, and localized effects to species and environmental quality based upon nonexceedance of threshold values in chemical profiles. However, pesticides may be used on Refuge lands where substantial effects to species and the environment are possible (exceed threshold values) in order to protect human health and safety (e.g., mosquito-borne disease). For more information on strategies related to control of pests, see Appendix E.

## 2.4.9 Law Enforcement

**Officers' Responsibilities**
Fish and wildlife law enforcement issues on lands and waters of the James Campbell NWR are under the jurisdiction of the Service Zone Officer based in Honolulu. The role of the Zone Officer is to conduct and document law enforcement incidents and coordinate and/or meet with all refuge project leaders, law enforcement supervisors, and refuge officers. The Hawaiian and Pacific Islands Zone Officer is highly mobile and is frequently deployed temporarily to various areas throughout the State

of Hawai„i and across the Pacific Region. The need for a dedicated Refuge Officer for the Complex has been identified in the Implementation Plan (Appendix C).

**Officers' Authority**
The Zone and Refuge Officers are primarily responsible for enforcing refuge and wildlife laws, including but not limited to:

- Administration Act;
- The Lacey Act;
- Archaeological Resource Protection Act;
- Endangered Species Act;
- Migratory Bird Treaty Act; and
- Marine Mammal Protection Act.

Zone and Refuge Officers are also empowered to enforce all criminal laws, including traffic violations, drugs, and warrants for arrest as they relate to trespass, hunting, fishing, and the taking wildlife on Federal lands, and in some instances boating safety related to refuge lands and waters. Service Officers work joint patrols and coordinate with the Hawai'i Department of Land and Natural Resources-Division of Conservation and Enforcement (DLNR-DOCARE), Honolulu Police Department (HPD), and the Sheriff Division of the State Department of Public Safety.

## 2.5 Alternative Descriptions

These alternatives represent broad, thematic approaches to management of the Refuge, recognizing the latitude managers have within the framework of Refuge System laws and policy (Table 2-1). The alternatives reflect direction in the Administration Act, Service policy for administration and management of refuges, and a host of ongoing conservation initiatives affecting the Hawaiian Islands. The alternatives were developed to address a suite of issues, and indeed are structured to track the issues, challenges, and opportunities presented in Chapter 1.

As an integrated CCP and EA, the details of the alternatives are described in terms of the main components of a CCP, namely measurable objectives and strategies to achieve those objectives. Most importantly, these alternatives are designed to help James Campbell NWR contribute to the mission of the Refuge System; meet the purpose for which the Refuge was established, and help achieve the Refuge vision, goals, and objectives. Stepdown plans for Visitor Services, Transportation, and Climate Change would be developed under Alternatives B and C. Except for scheduled docent tours by special use permits, EE program activities, and year-round access along the shoreline; the Refuge will be closed to general public entry until new visitor facilities are constructed and additional staff members are acquired to manage them.

### 2.5.1 Alternative A: Continue Current Management

Intensive management of threatened and endangered waterbird species and their habitat at the Ki„i and Punamanō Units of the Refuge would continue to focus on protection and successful nesting as part of the Statewide effort to implement the Hawaiian Waterbird Recovery Plan. Public use programs would remain virtually unchanged. Units would remain closed to the public except by SUP

issued for EE, research, wildlife observation, and wildlife photography on a case-by-case basis. Newly acquired expansion lands would receive custodial oversight only, no habitat restoration and no additional visitor services. Both current aquaculture leases will remain in effect until 2023 at which time, by prior agreement, they will expire.

### 2.5.2 Alternative B: Partial Restoration and Management of Refuge Expansion Lands

In addition to waterbird management actions identified in Alternative A, highest priority wetlands and coastal dunes on expansion lands would be restored and fenced to exclude large predators. By 2016, a Visitor Services Plan (VSP) would be developed to address a variety of wildlife-related public use activities. This plan will identify, evaluate, and carefully select sites and locations for infrastructure needed to fully implement a safe and meaningful program for the public. Infrastructure needs identified by the plan would include safe and compatible roads, parking areas, trails, overlook, etc. The VSP will identify new special regulations that may be needed to protect sensitive wildlife resources, the fragile coastline, and the visiting public. Other considerations include: The Refuge will cooperate with other agencies and the Kahuku community to develop, evaluate, and implement feasible projects to reduce projected flooding impacts in the local area while enhancing or protecting valuable natural resources on the Refuge; and both current aquaculture leases will remain in effect until 2023 at which time, by prior agreement, they will expire.

### 2.5.3 Alternative C: Full Restoration and Management of Refuge Expansion Lands

In addition to all of the management actions identified in Alternatives A and B, all wetlands, coastal dunes/strand and scrub/shrub habitats would be restored and managed. Trial use of predator-proof fencing would be initiated on selected dune or wetland sites to protect nesting seabirds and waterbirds. Abandoned aquaculture facilities would be cleaned up and remnant wetland habitat would be restored to natural conditions or other approved uses. If we determine that the Service does not currently have management authority for the shoreline adjacent to the Refuge coastline, we will pursue an Executive order from the Governor of Hawai,,i for jurisdiction to help fulfill the Refuge purpose and ensure compatibility of uses.

We see our work resulting in all visitors and local communities gaining a greater connection with nature, sense of place, respect for their environment, and a lifelong interest in and participation in the conservation, protection, and enhancement of wildlife, plants and their habitats. The Refuge is considered by many to be one of the best areas in Hawai,,i to view endangered waterbirds. High-quality wildlife viewing will continue and be expanded on the Refuge through the development and maintenance of trails, boardwalks, and observation sites.

**Table 2.1**

| James Campbell NWR Management Alternatives Summary | | | | | |
|---|---|---|---|---|---|
| **Key Themes** | | **Objectives** | **Alt A** | **Alt B** | **Alt C** |
| HABITATS | Intensively Managed Wetland Habitat | **1.1** Aeʻo loafing & foraging | 50-75 ac | 50-75 ac | 90-115 ac |
| | | **1.2** Aeʻo breeding | 20 ac | 20 ac | 20 ac |
| | | **1.3** ʻAlae keʻokeʻo & ʻalae ʻula loafing & foraging | 30-40 ac | 30-40 ac | <59 ac |
| | | **1.4** ʻAlae keʻokeʻo & ʻalae ʻula breeding | 15-20 ac | 15-20 ac | <30 ac |
| | Natural Wetland Habitat | **1.5** ʻAlae keʻokeʻo & ʻalae ʻula life-history | 18-25 ac | 25-32 ac | 32-51 ac |
| | Remnant Wetland Habitat | **1.6** Waterbirds & migratory birds | 0 ac | 10-25 ac | 25-67 ac |
| | Coastal Strand Dune Habitat | **3.1** Restore, protect, and manage | 0 ac | 50-100 ac | 100-185 ac |
| | | **3.2** Improve seabird nesting site on runway | 0 ac | <10 ac | 20-28 ac |
| | Scrub / Shrub Habitat | **2.3** Restore scrub/shrub | 0 ac | <20 ac | <312 ac |
| **Expansion Lands** | | **2.1** Complete Land Acquisition | ✓ | ✓ | ✓ |
| | | **2.2** Plan & Construct Refuge Facilities | | Develop site plans; Design/build new HQ/VC/EE facility | Design/build new HQ/VC/EE facility, maintenance shop, bunkhouse & greenhouse |

| Management Alternatives Summary (continued) | | | | |
|---|---|---|---|---|
| **Key Themes** | **Objectives** | **Alt A** | **Alt B** | **Alt C** |
| **Scientific Data** | **4.1** Conduct inventory and monitoring | Monitor impacts of pest plants & animals; and movements of endangered waterbirds | Track nesting success; impacts of pest plants & animals; and movements of endangered waterbirds | Track nesting success; impacts of pest plants & animals; and movements of endangered waterbirds with GIS data layer development. Initiate data collection volunteer program (i.e., bird surveys) |
| | **4.2** Facilitate research & scientific assessments | | Establish research partnerships | Form research partnerships; and develop climate change assessment protocols |
| **Visitor Services** | **5.1** Provide EE | EE is provided by SUP for 1,500 students | 3,000 students or up to 6,000 students with construction & staffing of EE facility | Up to 6,000 students with construction & staffing of EE facility |
| | **5.2** Offer new visitor opportunities, primarily wildlife observation and photography | Maintain current level; 500-800 visitors annually | 5,000 visitors annually along coastline and Ki,,i; and up to 210,000 w/ construction & staffing of VC | 5,000 visitors annually along coastline and Ki,,i; and up to 210,000 w/ construction & staffing of VC |
| **Cultural & Historic Resources** | **6.1** Enhance awareness, protection, & appreciation | Consult Native Hawaiian & historical societies to develop interpretive materials; NAGPRA training for staff | Consult Native Hawaiian & historical societies to develop interpretive materials; NAGPRA training for staff | Consult Native Hawaiian & historical societies to develop interpretive materials; NAGPRA training for staff; Develop GIS layer for avoidance of known sites |
| **Flood Damage Reduction for the Town of Kahuku** | **7.1** Support feasible flood reduction efforts for Kahuku | Cooperate in planning process | Cooperate in planning process; maintain Walkerville Unit as potential flood reduction project area | Cooperate in planning process; maintain Walkerville Unit as potential flood reduction project area |

## 2.6 Goals, Objectives, Strategies, and Rationale

Goals and objectives are the unifying elements for successful, adaptive refuge management. They identify and focus management priorities, resolve issues, and link to refuge purposes, Service policy, and the Refuge System mission.

A CCP describes management actions that help bring a refuge closer to its vision. A vision broadly reflects the refuge purposes, Refuge System mission and goals, other statutory requirements, and larger-scale plans as appropriate. Goals then define general targets in support of the vision, followed by objectives that direct effort into incremental and measurable steps toward achieving those goals. Finally, strategies identify specific tools and actions to accomplish objectives. Unless specifically stated, all objectives are applicable throughout the life of this plan.

In the development of this Draft CCP, the Service has prepared an effects analysis (Chapter 6) for each of the alternative sets of management actions derived from management goals, objectives, and implementation strategies. The goals for the James Campbell NWR are presented on the following pages. Each goal is followed by one or more objectives that pertain to it. The goal order does not imply any priority in this Draft CCP/EA. Some objectives pertain to multiple goals and have simply been placed in the most reasonable spot. Similarly, some strategies pertain to multiple objectives and for clarity these strategies are listed under each relevant objective. Following the goals, objectives, and strategies, a brief rationale is provided. This rationale generally describes how management strategies will be implemented to achieve the intended objectives. The rationale may also, where necessary, discuss means to minimize potential impacts to nontarget species and habitats. It also provides further background information pertaining to the importance of an objective relative to legal mandates for managing units of the Refuge System, including refuge purpose, trust resource responsibilities (federally listed threatened and endangered species and migratory birds), and maintaining/restoring biological integrity, diversity, and environmental health.

*A honu hatchling scoots its way to the sea  Mike Silbernagle/USFWS*

## 2.6.1 Goal 1. Protect and manage seasonal wetland habitats to meet the life-history needs of endangered waterbirds to promote their recovery.

**Objective 1.1. Intensively manage for ae‘o loafing and foraging habitat.**

Manage seasonal wetland habitat for loafing and foraging ae,,o throughout the year on approximately115 ac of the Ki,,i Unit with the following characteristics:

- Open water (1-6 in) and mudflat (saturated and dry) interspersed with 30-60% cover of emergent vegetation (e.g., cattail), grasses (e.g., sprangletop, knot-grass, millet), and sedges (e.g., saltmarsh bulrush, California bulrush, *Fimbrystlis* sp.) providing a mosaic;
- Less than 25% cover of pest plants including marsh fleabane, *Batis*, California bulrush, and California grass;
- Sufficient benthic and nektonic macroinvertebrates and small fish to provide forage on a rotational basis for up to 200 ae,,o;
- No cats or dogs; and
- Documented predation below 10 individual ae,,o per year.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Total acreage meeting objective characteristics*** | 50-75 | 50-75 | 90-115 |
| Drawdown in specified impoundments from approximately March-July (control fish and promote invertebrates/algal growth, plant response) | ✓ | ✓ | ✓ |
| Flood after vegetation treatment (mowing, tilling, herbicide, prescribed fire) to promote foraging | ✓ | ✓ | ✓ |
| Pulse water to promote abundance and availability of invertebrates | Monthly | Monthly | 3 X Monthly |
| Eliminate pest roost trees for cattle egrets | | | ✓ |
| Fencing, live-trapping, snap-traps and bait stations to reduce predation | ✓ | ✓ | ✓ |
| Control pest plants using: herbicide application, prescribed fire, mowing, rototilling, disking, and brush cutting | ✓ | ✓ | ✓ |
| Create openings (interspersion) in dense vegetation | | | ✓ |
| Monitor predator abundance (i.e., track tunnels) to evaluate effectiveness of predator control efforts | | | ✓ |

***Rationale:*** Ae,,o require different loafing and foraging habitats during the breeding (late February-July) and nonbreeding seasons. Recently hatched ae,,o (<14 days old) require shallow water of less than 2 inches to forage. During the remainder of the year fledgling and adult ae,,o can forage in water as deep as 6 inches.

Seasonally regulating water depth stimulates germination of desirable and beneficial plant species, controls undesirable plants, and provides a variety of macroinvertebrates for young and adult ae,,o to feed on, thereby creating and maintaining maximized production and carrying capacity of the

wetlands. In addition to providing forage, seasonally regulated water depths provide a mosaic of open water and vegetation as microhabitat for ae,,o thermoregulation and cover during inclement weather.

Mowing, prescribed fire, herbicide application, rototilling, and disking are all suitable techniques for creating the desired mosaic of vegetation, open water, and mudflats by opening dense contiguous patches of *Batis*, California grass, marsh fleabane, California bulrush, water hyssop, or cattail. These management techniques also benefit a variety of other wetland dependent species including koloa maoli, ,,alae ke,,oke,,o,,,alae ,,ula, wintering waterfowl (dabbling ducks), and shorebirds.

For more information on strategies related to control of pests, see Appendix E.

**Objective 1.2. Intensively manage wetland habitat for ae‘o breeding.**

Provide seasonal wetland habitat for breeding ae,,o from February-July on 20 acres of the Ki,,i Unit with the following characteristics:

- Open water (<3 in) and mudflat (saturated and unsaturated) with <25% cover of emergents, grasses, and sedges providing a mosaic;
- Undulating, irregular bottom topography creating unsaturated mudflats with gradual slopes during drawdown for nesting adjacent to foraging habitat;
- Predation limited to no more than 5 documented events per year;
- Less than 25% cover of pest plants including marsh fleabane, *Batis*, water hyssop, California bulrush, and California grass; and
  Benthic and nektonic macro-invertebrates and small fish with densities of 400-600 invertebrates/$yd^2$.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Total acreage meeting objective characteristics*** | 20 | 20 | 20 |
| Flood for prebreeding (as a follow-up to mowing/rototilling, etc. to create nesting habitat) | ✓ | ✓ | ✓ |
| Slow drawdown rate (control fish and promote invertebrates/algal growth, plant response) | ✓ | ✓ | ✓ |
| Pulsing water to promote invertebrates for broods | Twice Monthly | Twice Monthly | Weekly |
| Control predators with fencing, live-trapping, snap-traps, and bait stations | ✓ | ✓ | ✓ |
| Control pest plants using: herbicide application, prescribed fire, mowing, rototilling, disking, and brush cutting | ✓ | ✓ | ✓ |
| Restricted public use (seasonal closures) and limited Refuge staff presence only at a level necessary to conduct monitoring and water management, under normal circumstance, 1-3 visits per week | ✓ | ✓ | ✓ |
| Monitor predator abundance to evaluate success of control efforts | | | ✓ |

***Rationale:*** Breeding ae,,o require dry to unsaturated mudflat habitat for building nests. Pre-breeding water level drawdowns help establish drier mudflats. Although saturated mudflats can be used as nest sites, adult ae,,o expend more energy building nests robust enough to counter the excess moisture. Initiation of the drawdown is timed to coincide with minimal or no ,,alae ke,,oke,,o nesting or chick rearing. This timing method is part of an overall cycle of wetting and drying of habitat, making it suitable to a greater number of birds throughout the year and increasing species diversity. Thus, ae,,o nesting habitat temporally follows where ,,alae ke,,oke,,o habitat existed previously.

Declining water levels increase areas of suitable nesting habitat. Ae,,o breeding season water drawdowns maximize the number of nests that an area can support. The target distance between nest site to vegetation and water is 0-20 feet. Slow drawdown rates also stimulate ample numbers and diversity of invertebrates throughout the brood rearing period, allowing adult ae,,o with broods to establish feeding territories and reduce inter-brood conflicts that can result in injury or death to young chicks.

Ae,,o are very easily disturbed during the nesting season. Since they nest in the open on exposed mudflats they evolved behaviors to help protect nests and young. One behavior of the adult is to depart the nest when perceived danger is detected, leaving the nest, eggs, or young exposed to ground or avian predators and the weather. Eggs can also be destroyed by prolonged exposure to high temperature, wind chill, and rain, all of which occur frequently in Hawai,,i. Human disturbance must be minimized during the nesting period to reduce the risk of nest abandonment. Thus, public access is generally closed during this time.

Ae,,o nests, eggs, and young are also vulnerable to a variety of predators including rats, mice, mongooses, bullfrogs, dogs, cats, cattle egrets, and ,,auku,,u. It is critical to control predators during the nesting season, thereby increasing nesting and fledging success. These management techniques also benefit a variety of other wetland dependent species including koloa maoli, ,,alae ke,,oke,,o, ,,alae ,,ula, wintering waterfowl (dabbling ducks), and shorebirds.

**Objective 1.3. Intensively manage seasonal wetland habitat for ‘alae ke‘oke‘o and ‘alae ‘ula loafing and foraging.**

Provide seasonal wetland habitat for loafing/foraging ,,alae ke,,oke,,o and ,,alae ,,ula throughout the year on approximately 50 ac of seasonal wetlands and 9 ac of associated dikes at Ki,,i with the following characteristics:

- Mudflat (dry and saturated) and open water (<1-18 in) interspersed with 30-60% cover of tall (3-8 ft.) emergent vegetation, grasses, and sedges that provide seed and green browse and a mosaic of concealment cover, open water, and thermal cover;
- <25% cover of pest plants including marsh fleabane, *Batis*, water hyssop, California bulrush, and California grass;
- Adjacent short (<4 in), grassy uplands (especially dikes) for foraging;
- Interspersed vegetation with sufficient edge providing visual barriers to maximize territories available for breeding;
- Predation levels of no more than 5 individual ,,alae ke,,oke,,o and 1 ,,alae ,,ula per year;
- *Tilapia* numbers maintained at a level promoting algal growth and other desirable plants such as *Ruppia maritima* as forage; and
- Abundant epiphytic invertebrates (i.e., dragonflies), crayfish, and aquatic benthic/nektonic macroinvertebrates to support up to 200 ,,alae ke,,oke,,o and 100 ,,alae ,,ula on a seasonal basis.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Total acreage meeting objective characteristics*** | 30-40 | 30-40 | <59 |
| Extended hydroperiod to promote epiphytic invertebrates | ✓ | ✓ | ✓ |
| Flood after vegetation treatment (mowing, tilling, etc.) to promote foraging | ✓ | ✓ | ✓ |
| Slow drawdown rate (control fish and promote invertebrates/algal growth, plant response) | ✓ | ✓ | ✓ |
| Fencing, live-trapping, snap-traps and bait stations to reduce predation | ✓ | ✓ | ✓ |
| Monitor predator abundance to evaluate effectiveness of predator control efforts | | | ✓ |
| Control pest plants using: herbicide application, prescribed fire, mowing, rototilling, disking, and brush cutting | ✓ | ✓ | ✓ |

***Rationale:*** While ʻalae keʻokeʻo and ʻalae ʻula occupy similar loafing and foraging habitat, there are differences between the speciesʻ needs. ʻAlae keʻokeʻo use earlier successional stages of wetland habitat with a greater open water to vegetation ratio. They also typically occupy deeper water than ʻalae ʻula. ʻAlae ʻula prefer late successional stages comprised of dense, robust vegetation with greater seclusion. ʻAlae keʻokeʻo spend more time loafing in a flock on open water and dikes, whereas ʻalae ʻula are more solitary and occupy areas around the base of robust emergent vegetation or dikes. ʻAlae ʻula use open water primarily as a corridor between areas of suitable habitat.

Kiʻi ponds A and E contain a high percentage of *Batis* which provides habitat for ʻalae ʻula, while other ponds are managed for other species. The mosaic of open water and dense vegetation provides areas for thermoregulation and cover and increases habitat diversity. Mowing, disking, prescribed fire, herbicide application, and rototilling are all techniques suitable to open dense contiguous patches of *Batis*, California grass, marsh fleabane, California bulrush, water hyssop, or cattail-dominated areas. These techniques also return nutrients to the wetland ecosystem and benefit a variety of other water-related species including koloa maoli, wintering waterfowl, and shorebirds.

On the Kiʻi Unit, grass covered dikes are important habitat for ʻalae keʻokeʻo and ʻalae ʻula, as well as other species such as kioea. One wide dike is utilized by many species and is known as the C/F Dike. Mowing of this dike to maintain a grass height of less than 4 inches provides foraging areas where ʻalae keʻokeʻo and ʻalae ʻula can graze on short grass and feed on associated invertebrates.

**Objective 1.4. Intensively manage seasonal wetland habitat for ʻalae ʻula and ʻalae keʻokeʻo breeding.**

Provide seasonal wetland habitat for breeding ʻalae ʻula and ʻalae keʻokeʻo throughout the year on approximately 30 ac on Kīlauea with the following characteristics:

- Mudflat (dry and saturated) and open water (<1-18 in) interspersed with 30-60% cover of tall (3-8 ft.) emergent vegetation, grasses, and sedges that provide seed and green browse and a mosaic of concealment cover, open water, and thermal cover;
- Less than 25% cover of pest plants including marsh fleabane, *Batis*, water hyssop, California bulrush, and California grass;
- Interspersed vegetation with sufficient edge providing visual barriers to maximize territories available for breeding;
- Predation of no more than 5 individual ʻalae keʻokeʻo and 1 ʻalae ʻula per year;
- *Tilapia* numbers constrained to a low level, promoting algal growth and other desirable plants such as *Ruppia maritima* as forage;
- Abundant epiphytic invertebrates (e.g., dragonflies), crayfish, and aquatic benthic/nektonic macroinvertebrates to support up 200 ʻalae keʻokeʻo and 100 ʻalae ʻula on a seasonal basis;
- Brood rearing in close proximity to nesting habitat; and
- Stable water levels during laying and incubation.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Total acreage meeting objective characteristics*** | 15-20 | 15-20 | <30 |
| Extended hydro-period to promote epiphytic invertebrates | ✓ | ✓ | ✓ |
| Flood to sufficiently inundate emergent vegetation | ✓ | ✓ | ✓ |
| Slow drawdown rate (control fish and promote invertebrates/algal growth, plant response) | ✓ | ✓ | ✓ |
| Fencing, live-trapping, snap-traps, and bait stations to reduce predation | ✓ | ✓ | ✓ |
| Control pest plants using herbicide application, prescribed fire mowing, rototilling, brush cutting, disking | ✓ | ✓ | ✓ |
| Mowing, rototilling, brush cutting, and/or prescribed fire to create openings in dense vegetation | ✓ | ✓ | ✓ |
| Maintain stable water levels during laying and incubation | ✓ | ✓ | ✓ |
| Partial to complete public closure to minimize human disturbance | ✓ | ✓ | ✓ |
| Monitor predator abundance to evaluate effectiveness of predator control efforts | | | ✓ |

***Rationale****:* ʻAlae keʻokeʻo and ʻalae ʻula prefer stable water levels for nest building and nesting. When preparing an impoundment for ʻalae keʻokeʻo and ʻalae ʻula nesting, water levels are raised to a depth of 8-15 inches and maintained at a constant level to provide adequate nest sites that are secure from predation. Fluctuating water levels are not desirable, requiring nesting adults to continually build the nest up or have it isolated on dry ground and subject to greater predation.

During brood rearing periods, however, water levels are pulsed infrequently to provide physical barriers between brood territories and provide greater access to macroinvertebrates that are eaten by adults in breeding condition and also fed to developing chicks. These invertebrates are an important protein source for proper development.

The amount of vegetative cover in an impoundment varies with the duration between habitat management actions. As succession from open water to a more vegetation-dominated wetland occurs, it favors different species. ʻAlae keʻokeʻo are adept at nesting in a more open setting where there is approximately 30 percent cover of emergent vegetation. ʻAlae ʻula prefer a more vegetated system with about 60 percent cover.

Because of rapid and year-long plant growth in Hawaiʻi, habitat manipulation generally requires removal of all or nearly all vegetation (generally every 2-3 years) from a managed wetland impoundment to increase the time before follow-up management actions are needed. In the habitat preparation phase, dewatering followed by mowing, tilling, and herbicide application are used to achieve the mosaic. During the managing phase when water is in the impoundment, water level manipulation helps to create the desired percentage of vegetation and interspersion. Each impoundment can be managed independently in this manner, varying the habitat to meet wildlife needs.

*Habitat manipulation Mike Silbernagle/USFWS*

Ample food supply is important to build and maintain a healthy breeding population at a given site. Pest fish, such as *Tilapia* spp., are known to compete for food eaten by ʻalae keʻokeʻo and ʻalae ʻula. They also degrade water quality, which can affect invertebrate densities and plant growth. During habitat manipulation, slow drawdowns of water levels are used to concentrate undesirable fish and ultimately remove them from the environment. Following their death during dewatering, the remains are allowed to dry and decompose naturally or are tilled into the soil, increasing soil nutrients that aid in promoting invertebrate and plant response. Botulism is a concern so evidence of botulism poisoning is closely monitored for during decomposition.

ʻAlae keʻokeʻo and ʻalae ʻula are less susceptible to disturbance during nesting compared with aeʻo and this relates to their nest location, nesting habitat, and response to disturbance. Since ʻalae keʻokeʻo and ʻalae ʻula nest in open water or dense vegetation with concealment, their response to disturbance is to remain motionless on the nest. As a result, public use is limited during the ʻalae keʻokeʻo and ʻalae ʻula nesting season. Most of the time it is difficult to see a nest even at a relatively close distance.

Recognizing public tours and educational programs are important, there is a need to restrict access for such activities in areas where nesting and brood rearing is concentrated. The locations of nest are monitored and visitors either directed away from the areas or led quickly through the area to minimize human disturbance.

**Objective 1.5: Manage natural wetland habitat for ʻalae keʻokeʻo and ʻalae ʻula.**

Provide and manage up to 51 ac of natural wetland habitat of the Punamanō Unit to meet all life-history needs of ,,alae ke,,oke,,o and ,,alae ,,ula throughout the year with the following characteristics:

- Mudflat (dry and saturated) and open water (<1-18 in) interspersed with 30-60% cover of tall (3-8 ft.) emergents, grasses, and sedges that provide a mosaic of concealment cover, open water, and thermal cover;
- Less than 40% cover of pest plants including marsh fleabane, *Batis*, water hyssop, California bulrush, California grass, Christmas berry, and koa haole;
- Adjacent short (<3 in), grassy uplands for foraging;
- Predation levels of no more than 5 individual ,,alae ke,,oke,,o and 1 ,,alae ,,ula per year.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Total acreage meeting objective characteristics*** | 18-25 | 25-32 | 32-51 |
| Fencing, live-trapping, snap-traps and bait stations to reduce predation | ✓ | ✓ | ✓ |
| Control pest plants using: herbicide application, prescribed fire, mowing, rototilling, disking, and brush cutting | ✓ | ✓ | ✓ |
| In selected sites, investigate and implement, if feasible, installation of small water control structures to partially restore water level management capability and increase habitat diversity | | ✓ | ✓ |
| Monitor predator abundance to evaluate effectiveness of predator control efforts | | | ✓ |

***Rationale:*** Currently, with no water control structures, intensive water management capabilities are lacking at the Punamanō Unit. Therefore, the timing, duration, and water level cannot be managed. Natural weather patterns and subsurface ground water movement control the hydrology of the unit.

Maintenance (nonbreeding) habitat is created, maintained, or enhanced mostly at the wetland/upland interface because mowing, tilling, and other mechanisms can be undertaken to control vegetation. Access to these areas is limited and most work here must be accomplished by hand. Mudflat habitat is only available along portions of the wetland perimeter. Presence, absence, and amount of mudflat are dependent on natural fluctuating water level. Natural undulating vegetation edges only create limited areas for thermoregulation.

Breeding habitat for ,,alae ke,,oke,,o and ,,alae ,,ula is restricted to centrally located stands of emergent vegetation. Vegetation control in the wetland occurs infrequently due to unavailability of adequate equipment (e.g., aquatic weed cutters and excavators) on a regular basis. As a result, lower numbers of ,,alae ke,,oke,,o and ,,alae ,,ula are supported here than in intensively managed wetland units. Nesting is confined to bulrush stands on this unit. Macro- and other invertebrates are produced, but competitive fish such as *Tilapia* are not controlled and likely reduce food availability for endangered ,,alae ke,,oke,,o and ,,alae ,,ula.

Mowing, prescribed fire, herbicide application, and rototilling are all tools that are available to open wetland shoreline areas of *Batis*, California grass, marsh fleabane, Christmas berry, and koa haole.

Chipping can reduce the removed material that cannot be disposed of by techniques identified above. This will speed recovery of the area by reducing the time necessary for natural decomposition to occur. Controlling these species promotes a mosaic of wetland fringe and upland vegetation, open water, and mudflats as suitable habitat for ʻalae keʻokeʻo and ʻalae ʻula. Small pieces of herbaceous plant material created from mowing and other techniques also become available to ʻalae keʻokeʻo and ʻalae ʻula for nest construction.

A 16-acre wetland site (currently unmanaged) in the southeast corner of the Punamanō Unit, adjacent to Nudist Camp Road, has been partially drained by small lateral surface ditches since the early 1900s. This area will be investigated to determine if the installation of small water control structures in these lateral ditches may partially restore historic water levels and provide a minimal amount of water management capability that will increase overall wetland habitat diversity in this unit, benefitting both ʻalae keʻokeʻo and ʻalae ʻula.

**Objective 1.6. Manage remnant wetland habitat within acquisition area for the benefit of endangered waterbirds and migratory birds.**

Once acquired, protect and maintain approximately 69 ac of remnant seasonal wetlands within the acquisition boundary for James Campbell NWR expansion to meet these characteristics:

- Mudflat (dry and saturated) and open water (<1-18 in) interspersed with 30-60% cover of tall (3-8 ft.) emergent grasses and sedges that provide a mosaic of concealment cover, open water, and thermal cover;
- Less than 40% cover of pest plants including marsh fleabane, *Batis*, water hyssop, California bulrush, California grass, Christmas berry, and koa haole;
- No ironwood or kiawe;
- Interspersed vegetation with sufficient edge providing visual barriers to maximize territories available for breeding;
- Documented predation of no more than 5 aeʻo per year; and
- Limited/controlled public use to minimize disturbance.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Total acreage meeting objective characteristics*** | 0 | 10-25 | 25-67 |
| Fencing, live-trapping, snap-traps and bait stations to reduce predation | | ✓ | ✓ |
| Control pest plants using: herbicide application, prescribed fire, mowing, rototilling, disking, and brush cutting | | ✓ | ✓ |
| Create desirable mosaic of openings in vegetation by mowing, rototilling, disking or prescribed fire | | ✓ | ✓ |
| Monitor predator abundance to evaluate effectiveness of predator control efforts | | | ✓ |

***Rationale:*** Unmanaged semi-permanent and temporary wetlands within the approved acquisition boundary provide habitat for a variety of species. Natural weather patterns, subsurface ground water movement, and small surface ditches control the hydrology of the unit. No active water management or water management facilities (e.g., pumps and water control structures) currently exist for the purpose of managing these wetlands. Once acquired, Service management will mostly involve

controlling undesirable vegetation and, where feasible, limited water level management. Major alteration of the landscape is not required to enhance and maintain wetlands capable of supporting waterbirds because in most areas soils and hydrology are still functioning in a relatively natural manner.

Water levels, timing, and duration cannot be controlled as on Ki„i; where water control structures; dedicated water supply; bottom topography; and confined impoundments allow detailed and specific water regimes to be established and maintained. Maintenance (nonbreeding) habitat may be created, maintained, or enhanced in suitable and accessible wetland/upland interface where mowing, tilling and other mechanisms can be undertaken to control vegetation. Many areas will not be enhanced because of the inaccessibility to equipment.

Lower numbers of ‚alae ke„oke„o and ‚alae „ula will be supported here than in an intensively managed wetland. Nesting will be confined to emergent stands. Macro- and other invertebrates are produced, but competitive fish such as *Tilapia* are not controlled and they likely reduce food for endangered ‚alae ke„oke„o and ‚alae „ula. Life-history needs of endangered waterbirds will be met in at least part of the area throughout the year under this objective. Other benefiting species include the koloa maoli and a variety of migratory wintering waterfowl, primarily dabbling ducks such as koloa māpu (northern pintail), koloa mohā (northern shoveler), and green-winged teal. Several shorebird species will also benefit including, ‚akekeke, kolea, and „ū„lili.

There will be less of a mosaic of open water and vegetation to provide thermoregulation during inclement weather. Mowing, prescribed fire, herbicide application, disking, and rototilling to open *Batis*, California grass, marsh fleabane, Christmas berry, and koa haole dominated areas to create the mosaic of vegetation, open water, and mudflats will be retained as management tools, but suitable areas for implementing one or more of these techniques will be greatly reduced under this objective because of access restrictions and the inability to effectively manage water.

Selected sites will be investigated for the feasibility of installing small water control structures to partially provide water level management capability in these remnant degraded wetlands. In addition, several existing groundwater wells on the acquisition area have been used in the past for commercial aquaculture operations. These wells, as well as surface water runoff, may also be used to partially provide water level management capabilities. This limited capability may improve the control of pest species and increase habitat diversity.

*Ae‘o ohana  Laura Beauregard/USFWS*

**Objective 1.7. Manage aquaculture ponds, in voluntary cooperation with lessees, for waterbirds and shorebirds.**

Enhance, protect and manage up to 242 ac. (currently under lease until 2023) to meet these characteristics:

- Mudflat (dry and saturated) and open water (<1-18 in) interspersed with 30-60% cover of tall (3-8 ft.) emergent grasses and sedges that provide a mosaic of concealment cover, open water, and thermal cover;
- Less than 40% cover of pest plants including marsh fleabane, *Batis,* water hyssop, California bulrush, California grass, Christmas berry, and koa haole;
- No ironwood or kiawe;
- Interspersed vegetation with sufficient edge providing visual barriers to maximize territories available for breeding;
- Documented predation level of no more than 10 ,,alae ke,,oke,,oand 4 ,,alae ,,ula per year; and
- Limited/controlled public use to minimize disturbance.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Total acreage meeting objective characteristics*** | 0 | <242 | <242 |
| Passively manage aquaculture ponds in voluntary cooperation with lessees through water level management | ✓ | ✓ | ✓ |
| Conduct aquaculture ponds assessment and develop a restoration plan | | ✓ | ✓ |
| Fencing, live-trapping, snap-traps and bait stations to reduce predation | | ✓ | ✓ |
| Control pest plants using: herbicide application, prescribed fire, mowing, rototilling, disking, and brush cutting | | ✓ | ✓ |

***Rationale:*** Aquaculture ponds are currently under lease with the Service on 242 acres of the Refuge. These leases are scheduled to expire in 2023, when they will permanently revert to Refuge management. Lessees may relinquish their leases prior to 2023 on a voluntary basis, or leases may be terminated if they fail to meet the conditions of the leases. Under current aquaculture operations, many of the ponds may be idle for extended periods of time (months to years). These idle ponds have potentially high habitat value for endangered waterbirds and migratory birds. With relatively little active management, primarily water level management (raising and lowering water levels at desirable intervals), the additional wetland habitat can benefit these species. This provides an opportunity for voluntary cooperative management strategies between the lessees and the Refuge.

When the leases expire and/or when the ponds revert to Refuge management, they will be evaluated for more active and long-term management strategies. This process will begin with a comprehensive water management and resource analysis planned for 2018-2020.

**Objective 1.8. Provide wetland habitats to meet the life-history needs of koloa maoli.**

Enhance, protect and manage up to 50 ac. to meet these characteristics:

- Mudflat and open water containing an approximately 50:50 ratio of emergent plants to open water, with an irregular shoreline;
- Less than 40% cover of pest plants including marsh fleabane, *Batis,* water hyssop, California bulrush, California grass, Christmas berry, and koa haole;
- Protected near water nest sites;
- Abundant small invertebrates such as aquatic insects, snails and crustaceans (400-600 invertebrates/$yd^2$);
- No introduced aquatic vertebrates; and
- Limited/controlled public use to minimize disturbance.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Total acreage meeting objective characteristics*** | 0-5 | 10-15 | 15-25 |
| Support inter-agency efforts to promote the recovery of pure koloa maoli | ✓ | ✓ | ✓ |
| Monitor, research, and survey koloa maoli population | | | ✓ |
| Pulse water to promote abundance and availability of invertebrates | Monthly | Monthly | 3x Monthly |
| Control pest plants using: herbicide application, prescribed fire, mowing, rototilling, disking, and brush cutting | ✓ | ✓ | ✓ |

***Rationale:*** The koloa maoli is an endangered waterfowl endemic to the Hawaiian Islands. Koloa maoli eat primarily small invertebrates such as aquatic insects, snails, and crustaceans. They also eat freshwater limu (algae) and seeds of grasses, sedges, and other plants. They sometimes graze on grasses and legumes similar to geese. Pest fish (mosquito fish and *Tilapia*) compete with koloa maoli for food. Koloa maoli are more likely to use wetlands farther (more than 600 yds.) from houses, larger (0.75 ac.) wetlands, and those surrounded by more wetlands area (2.5 ac.) (Uyehara et al. 2007).

The Draft Revised Recovery Plan for Hawaiian Waterbirds lists the koloa maoli as having a high potential for recovery and a high degree of threat due to hybridization with mallard ducks, the greatest threat to this species‟ continued existence. Although birds on O,,ahu and Maui are thought to be primarily koloa-mallard hybrids, 3 pure koloa maoli were found at James Campbell NWR during a genetic testing survey in 2008. In addition to hybridization concerns, other hazards exist for koloa maoli. Known predators of eggs and ducklings include mongooses, cattle egrets, cats, dogs; and possibly rats and Samoan crabs. ,,Auku,,u and bullfrogs have been observed to take ducklings. Avian diseases are another threat to koloa maoli with outbreaks of avian botulism occurring annually throughout the State. Habitat improvements combined with feral mallard control may reduce extinction threats to koloa maoli (Uyehara, et al 2008).

## 2.6.2 Goal 2. Complete acquisition of the James Campbell NWR expansion to restore, protect and manage habitats according to Refuge purposes and to meet Refuge staff facility needs.

| **Objective 2.1. Complete the James Campbell National Wildlife Refuge Expansion Act land acquisition process.** | | | |
|---|---|---|---|
| Complete acquisition of lands identified in the Expansion Act by December 2013. | | | |
| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
| Continue coordination with Regional Office and Washington Office staff for logistical support to land acquisition | ✓ | ✓ | ✓ |
| Continue close coordination/cooperation with James Campbell Company to complete terms of purchase agreement | ✓ | ✓ | ✓ |
| Closely monitor transfer of State Water Use Permit to meet time restrictions for administrative transfer | ✓ | ✓ | ✓ |
| Continue to identify/pursue new opportunities for land acquisition that will serve/benefit Refuge purpose | ✓ | ✓ | ✓ |
| Pursue acquisition from willing sellers of small land inholdings within the Refuge boundary to complete/consolidate Refuge lands | | ✓ | ✓ |
| If needed, pursue Executive order from the State of Hawai,,i for jurisdiction to manage shoreline adjacent to Refuge to protect wildlife and ensure compatibility of uses | | | ✓ |

***Rationale:*** The James Campbell National Wildlife Refuge Expansion Act of 2005 authorizes the expansion of the existing Refuge by 800 ac for a total of 1,100 ac within the approved Refuge boundary. The purchase agreement between the Service and James Campbell Company has a sunset clause that mandates the acquisition be completed by December 2013. Funding has been obligated to complete the purchase and as of April 2011, parcels 1 and 4 (see Figure 3-2) have been purchased and are now part of the Refuge. Parcels 2 and 3 remain to be purchased.

Management jurisdiction for the new property boundary along the shoreline is under review, subject to the Service solicitor"s opinion. If we determine that the Service does not currently have management authority for the shoreline adjacent to the Refuge, we will pursue an Executive order from the Governor of Hawai,,i for jurisdiction to help fulfill Refuge purposes and ensure compatibility of uses. Under State law, when a compelling need or benefit may be met, an Executive order signed by the Governor may be issued to transfer management responsibility of the State shoreline corridor to the adjoining landowner, in this case the Refuge. This action, if approved and agreed upon by the State, would consolidate management and protection of highly valuable and sensitive coastal resources along this unique portion of coastline.

Water rights owned by James Campbell Company will be transferred to the Refuge upon sale. State Water Commission regulations allow for administrative transfer of water use permits if application is made within 60 days of land transfer. Administrative transfer precludes the need to apply for new water use permits on existing permitted wells.

In addition to lands currently planned for acquisition under the purchase agreement with James Campbell Company, other lands adjacent to or in the vicinity of the Refuge with potential high value and benefit to the Refuge may be identified and become available for purchase. In these cases, Service procedures and policies, including NEPA compliance and willing seller policy, would be followed to pursue acquisition of these potential additional lands.

**Objective 2.2: Develop site plans and construct new Refuge facilities.**

By the year 2014, identify suitable sites for complex headquarters, visitor center, and EE (HQ/VC/EE), and other Refuge facilities. Develop plans for and construct HQ/VC/EE facility with the following attributes:

- Leadership in Energy & Environmental Design certified;
- Energy efficient - in operation and in construction;
- Resource efficient - in operation and in construction;
- Non-polluting - in operation and production;
- Accessible - to provide equal use of the built environment for all people;
- Native plantings - landscape uses native plants adapted to O„ahu‘s north shore; and
- Local building materials - to minimize the energy embedded in their transportation.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| Develop site plans for areas to be managed as administrative lands | | ✓ | ✓ |
| Acquire approval and funding for design-build of new HQ/VC/EE facility | | ✓ | ✓ |
| Evaluate and construct, if feasible, a new Complex maintenance facility at a more desirable location (higher elevation, less harsh coastal environment, improved access) than current location | | | ✓ |
| Evaluate and implement, if feasible, restoration of existing residential home on Parcel 4 to provide adequate temporary housing for volunteers, interns, or researchers; or pursue location and construction of a standardized bunkhouse facility | | | ✓ |
| Construct greenhouse for native plant propagation | | | ✓ |
| Continue discussion with NOAA / non-government organizations about potential „īlio-holo-i-ka-uaua rehabilitation facility | | | ✓ |

***Rationale:*** Acquisition of the expansion lands will provide new opportunities to develop major new Refuge facilities that will benefit the public and staff. Sites on these lands may be suitable for construction of a headquarters, visitor center, and EE facility (HQ/VC/EE) to serve the Complex. Suitable site characteristics include consideration of public road access, proximity to utilities, and ground elevation. For nearly 20 years, the Refuge staff have worked out of a leased office space in Hale„iwa, 20 miles from the Refuge. This location does not serve the staff or the public well. A new HQ/VC/EE constructed on the James Campbell Refuge would be a tremendous boost to the visibility and image of the Service and could serve an estimated 210,000 visitors annually and up to 6,000 students.

The current location of the Complex maintenance facility is undersized and is exposed to harsh marine coastal winds that are highly corrosive to equipment and buildings due to salt spray. When fully acquired, sites on the Refuge expansion lands will be evaluated to determine their feasibility for a new maintenance facility that would better serve the growing management needs of the Complex and offer greater protection from harsh coastal conditions. A new bunkhouse would provide onsite, affordable temporary housing for volunteers, researchers or interns thereby greatly enhancing the ability of these persons to conduct work on the Refuge.

Leadership in Energy & Environmental Design is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies intended to improve performance in metrics such as energy savings, water efficiency, $CO_2$ emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts.

### 2.6.3 Goal 3. Restore and protect coastal strand/dune habitat and upland scrub/shrub to provide safe refuge for endangered ʻīlio-holo-i-ka-uaua and threatened honu, as well as provide habitat for seabirds, shorebirds, and migratory birds.

**Objective 3.1. Restore, protect, and manage coastal strand/dune habitat.**

Restore, protect, and manage a mosaic of up to 200 ac. of terrestrial habitat consisting of approximately 140 ac. of coastal dune/strand, up to 60 ac. of adjacent coastal scrub/shrub and to promote nesting and roosting habitat for 6 seabird species, as well as protected habitat for honu and ʻīlio-holo-i-ka-uaua. Coastal strand/dune habitat characteristics should be:

- Patchy distribution of low growing (2-8 ft.), native woody species (e.g., ʻilima, naupaka kahakai, pilo, wiliwili, naio, hala) as a mosaic;
- 30-40% cover of native grasses (e.g., ʻākiʻaki) and herbaceous vegetation (e.g.,Mauʻu, Pōhuehue) on dunes;
- Less than 10% of woody pest plant species (e.g., marsh fleabane, mangrove, Christmas berry, and koa haole);
- No ironwood or kiawe;
- Less than15% cover of herbaceous pest plant species;
- Predation limited to no more than six seabirds per year; and
- Restricted public use to protect fragile dunes habitat, particularly native plants; and to minimize human disturbance to ʻīlio-holo-i-ka-uaua, honu, seabirds, shorebirds, and other migratory birds.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Total acreage meeting objective characteristics*** | 0 | 50-100 | 100-185 |
| Remove marine debris | ✓ | ✓ | ✓ |
| Periodic mowing and brush-cutting to allow for breeze flow and pathways from the beach or dune crest where seabirds like to launch to nest sites further inland | | ✓ | ✓ |

| *Strategies Applied to Achieve Objective* | Alt A | Alt B | Alt C |
|---|---|---|---|
| Propagation and planting of native plant species | | | ✓ |
| Control pest plants using IPM appropriate techniques, including herbicide application, prescribed fire, mechanical removal, brush cutting, and hand pulling | | ✓ | ✓ |
| Predator control methods for pigs, cats, and dogs include trapping, fencing, and shooting | | ✓ | ✓ |
| Support volunteers and organizations such as Malama na Honu (Protect the Turtles) and O,,ahu Monk Seal Response Team to protect wildlife and inform public along shoreline | ✓ | ✓ | ✓ |
| Predator control methods for rodents and mongooses include bait stations, trapping, and fencing | | ✓ | ✓ |
| Fencing to limit human disturbance | | ✓ | ✓ |
| Test the use of predator-proof fencing to exclude all mammals; implement on a larger scale if feasible | | | ✓ |
| For nesting seabirds, minimize human disturbance until colony is well established; then provide appropriate viewing platforms or blinds for the public | | | ✓ |
| Refuge coastline closed to public use at night to protect nesting honu and seabirds | | ✓ | ✓ |
| Temporary or seasonal public closures in the Refuge-owned shoreline as necessary to protect nesting honu or pupping „īlio-holo-i-ka-uaua | | ✓ | ✓ |

***Rationale:*** Intact vegetative coastal dune communities are extremely rare throughout the main Hawaiian Islands and important to several rare and endangered animal and plant species. Coastal dune and associated beach strand habitat are used by endangered „īlio-holo-i-ka-uaua and threatened honu for hauling out, basking, and pupping or nesting respectively. This habitat also provides important foraging and loafing areas for migratory bird species such as the kioea, kōlea, and ,,akekeke. Soil texture, relative position to the shoreline, and desirable plant species provide suitable subterranean nest burrow habitat for ,,ua,,u kani and Newell‘s shearwater.

The Refuge coastline is at the northeast tip of the island where it is highly susceptible to accumulation of marine debris due to ocean currents and prevailing northeast wind. Honu , „īlio-holo-i-ka-uaua, and seabirds may be severely injured and even die after entanglement with fishing lines, fragments of trawl netting, or plastic packing straps. Seabirds caught in this debris may lose their ability to move quickly through the water, reducing their ability to catch prey and avoid predators; or they may suffer constricted circulation, leading to asphyxiation and death. Fishing line, nets, and ropes cut into the skin of „īlio-holo-i-ka-uaua or honu, leading to infection or painful amputation of flippers or tails. Honu frequently eat plastic bags, confusing them with jellyfish, their common prey. Seabirds eat polystyrene balls and plastic buoys, confusing them with fish eggs and

crustaceans. Beach clean-ups at the Refuge are scheduled 2 to 4 times annually, depending on the availability of volunteers.

Coastal dunes are fragile and easily altered by human activity. Livestock grazing and off-road-vehicle (ORV) use was and is occurring, having an impact on the substrate and vegetative community. Observed changes include "blowouts" in the dunes and the occurrence of pest plant species that likely came in with livestock food or mud tracked in with ORVs. These activities will be suspended as the land is acquired by the Refuge.

Removal of woody pest plants to maintain breeze flow is critical to aid in thermoregulation of nesting adults and prefledgling seabirds. During periods of high temperatures, seabirds depend on airflow to help maintain normal body temperature. Parents have to remain on the nest during incubation, making departure from the area infeasible because mortality of the developing embryo could occur. Sea breeze/air flow is also an important component to taking-off because of wing loading. Much like aircraft, seabirds tend to take off into the wind because it assists them in getting airborne more quickly with less energy expenditure.

Six seabird species were selected for priority management because of their habitat preferences at other nesting sites in Hawai,,i that resemble the conditions at the Refuge, the proximity of possible sources of colonizing birds, examples of previous restoration attempts at other sites that were successful, and their relatively higher resistance to small mammals such as mice that may be impossible to control in the early stages of colony restoration. In order of feasibility of attraction and establishment, the species are mōlī, ,,ua,,u kani, koa,,e,,ula, ,,a, ka,,upu, and Christmas shearwater. Other species including the ESA-listed ,,a,,o, the ,,ou, and many of the tropical terns will more likely be attracted and successfully nest here once other seabirds are already established.

Low intensity management on beach and dunes will include fencing, spot treatment of pest plants, and minimizing predation. For each species, the restoration methods can include manipulating the vegetation community; providing a mammal-free area; employing attraction techniques such as sound recordings, decoys, and mirrors to take advantage of the highly social nature of nesting seabirds; or actively translocating animals at the appropriate age, rearing them on site and releasing them in the hope that they will return at breeding age to the new colony. This final method has been recently successfully employed with short-tailed albatrosses in Japan and has also been used with fluttering shearwaters in New Zealand and Atlantic puffins in Maine. Existing habitat for each of the species suggested already exists in the approved acquisition site. Additional nest sites could be provided for koa,,e ,,ula and ,,ua,,u kani by using slabs of concrete building material to create shelters and by building wooden nest site structures above the ground for ,,ā (Rauzon 1999).

Predators such as rats, mongooses, cats, and dogs are the primary limiting factor to restoring and maintaining a seabird community. Predator control provides the opportunity for seabirds to recolonize important nesting habitat. Benefits will also be realized for wintering and resident shorebirds on areas managed for seabirds. Removal of pest species and increased loafing and foraging habitat will allow the Refuge to support a larger number of shorebirds, many coming from thousands of miles away.

**Objective 3.2. Improve potential seabird nesting site on abandoned Kahuku airfield runway.**

Restore, manage, and protect approximately 28 ac. of abandoned runway to promote nesting habitat with the following characteristics:

- Patchy distribution of low growing (2-8 ft.) naupaka kahakai as a mosaic;
- Less than 10% of woody pest plant species (e.g., marsh fleabane, mangrove, Christmas berry, and koa haole);
- No ironwood or kiawe;
- Less than15% cover of herbaceous pest plant species;
- Breeze flow corridors to aid in thermoregulation;
- Predation limited to no more than six seabirds per year; and
- Restricted public use to minimize human disturbance to nesting seabirds.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Total acreage meeting objective characteristics*** | 0 | <10 | 20-28 |
| Remove and control invasive woody growth on and along perimeter (aprons) of runway using a variety of techniques including cutting, mowing, grubbing, prescribed fire, and herbicide application | | ✓ | ✓ |
| Implement control methods for nonnative predators including trapping, baiting, fencing, and shooting | | ✓ | ✓ |
| Test the use of predator-proof fencing to exclude all mammals; implement on a larger scale if feasible | | | ✓ |
| Monitor seabird activity to determine future management actions | ✓ | ✓ | ✓ |
| Monitor encroachment of pest species | | ✓ | ✓ |
| Engage in attraction of birds using visual cues such as decoys, mirrors, and/or recorded calls of desired species | | | ✓ |

***Rationale:*** A short distance inland from the dunes, the abandoned World War II Kahuku runway could provide potential nesting habitat to albatross and other seabirds, similar to that found on abandoned runways at Midway Atoll, Tern Island, and other remote Pacific Islands. Mōlī, in particular, frequently and heavily use flat, open sites with low or interspersed vegetation for nesting. These conditions exist at several former military runways at several sites around the Pacific. The Kahuku runway is ideally located just a few hundred yards inland from the coast and downwind of the prevailing trade winds.

After years of inactivity, vegetation has encroached on much of the remaining Kahuku runway. The aprons of the runway proper, constructed primarily of compacted crushed coral, are largely covered with koa haole, kiawe, *Pluchea,* and ironwood. The runway was constructed of a light asphalt mix and has been invaded by pest vegetation to a lesser extent. Where small portions of the original runway remain open, native vegetation such as pōhuehue has become established. This low-growing plant is suitable for nesting habitat and will continue to be promoted. Sufficient airflow (breeze and wind) is a fundamental component of a suitable mōlī nesting site. Mōlī adults and chicks depend heavily on airflow to help regulate their body temperatures to help with takeoff and flight at inland

*Mōlī pair watches over chick USFWS*

sites. Removal of the existing dense woody pest vegetation along the runway will help to significantly restore a natural airflow over the site. Control of nonnative predators is essential to the establishment and success of any seabird colony on the main Hawaiian Islands. Several attempts by mōlī to individually colonize nearby coastal habitat over the past few decades have almost always resulted in the eggs, chicks, or adults being killed by predators, generally believed to be dogs.

As rising sea levels begin to negatively impact important seabird nesting sites in more vulnerable remote Pacific islands, nesting sites on the main Hawaiian Islands (which are generally higher in elevation) will become increasingly important. Unfortunately, suitable potential nesting sites in the main Hawaiian Islands are very uncommon due to loss of habitat and impacts from pest species. Potential nesting sites such as the abandoned Kahuku runway may take on significantly more importance in future decades.

Over the 15-year timeframe of this CCP, the use and benefits of the runway habitat for seabirds will be monitored and evaluated. The kioea, another important migratory bird species, is regularly observed using the remaining open portions of the runway for foraging and resting. This species will also benefit from the proposed management of the runway.

The few species of seabirds that successfully nest in very limited areas on the Island of O,,ahu are a reflection of the devastating impacts from predators, including rats, mongooses, cats, dogs, and pigs. These pest species are the primary limiting factor to reestablishing and maintaining a successful nesting seabird community. Despite predator control programs, predation can still be a serious problem. One management strategy to reduce or eliminate the damage would be to include predator exclosure fences and eradicate pests from within the fenced areas. Control and management of pest vegetation and predators provides an opportunity for seabirds to recolonize important nesting habitat.

**Objective 3.3. Restore scrub/shrub habitat within expanded boundary.**

Develop restoration plans for up to 312 ac. of scrub/shrub habitat considering the following:

- Native plants consistent with historic scrub/shrub habitats;
- Sparsely vegetated geological formations (e.g., coral outcrops) with potential to support nesting seabirds; and
- Cover plants within 30 yds. of wetlands to support life history needs of waterbirds.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Total acreage meeting objective characteristics*** | 0 | <20 | <312 |
| Conduct surveys and studies to determine desirable native vegetation community based on local site conditions including soil type, elevation, ground water table and proximity to shore | | ✓ | ✓ |
| Use IPM techniques to control/eradicate pest plants | | ✓ | ✓ |

| *Strategies Applied to Achieve Objective* | Alt A | Alt B | Alt C |
|---|---|---|---|
| Work with the Bishop Museum and other potential partners to determine the historic plant communities | | | ✓ |
| Develop/implement restoration program, to include outplanting of native species | | | ✓ |
| Determine the feasibility of establishing populations of the endangered ʻEwa hinahina and ʻākoko. | | | ✓ |
| Develop/implement plans to conduct major cleanup of abandoned aquaculture facilities and restore to natural conditions or other approved uses (i.e., visitor use facilities) | | | ✓ |

***Rationale:*** This area in the new Refuge boundary has not previously been managed by the Service. Much of the scrub/shrub habitat occurs over a coral shelf substrate. This habitat is limited on Oʻahu and supports several threatened or endangered plants. The extent of this coral substrate on the Refuge might be important for future restoration and recovery efforts for one or more of these species.

One of the most significant influences leading to the degradation and loss of native Hawaiian habitats has been the relentless influx of pest plants, many of these highly invasive. The Refuge plans to work with partners to restore a viable natural native plant community through removal of pest plants and outplanting of native plants that were part of the historic vegetative community. Plans to construct a greenhouse in objective 2.2 will enhance the Refuge's ability to promote native plant propagation for use on the Refuge.

### 2.6.4 Goal 4. Collect scientific information necessary to support adaptive management decisions.

**Objective 4.1. Conduct inventory, monitoring, and research to document progress and evaluate management strategies to guide management decisions.**

Throughout the life of the CCP, conduct high-priority inventory and monitoring (survey) activities that evaluate resource management and public-use activities to facilitate adaptive management. These surveys contribute to the enhancement, protection, use, preservation, and management of wildlife populations and their habitats on- and off-refuge. Specifically, they can be used to evaluate achievement of resource management objectives identified in this CCP. These surveys have the following attributes:

- Data collection techniques would have zero to minimal animal mortality or disturbance and zero to minimal habitat destruction;
- Collect minimum number of samples (i.e., water, soils, vegetative litter, plants, macroinvertebrates, vertebrates) to meet statistical analysis requirements for identification and/or experimentation in order to minimize long-term or cumulative impacts;
- Use proper cleaning of investigator equipment and clothing as well as quarantine methods, where necessary, would minimize the potential spread or introduction of pest species; and
- Projects will adhere to scientifically defensible protocols for data collection, where available and applicable.

| *Strategies Applied to Achieve Objective* | Alt A | Alt B | Alt C |
|---|---|---|---|
| Continue to encourage Refuge staff to publish in peer-reviewed scientific journals and attend professional society and agency-sponsored meetings/conferences | ✓ | ✓ | ✓ |
| Require researchers to use regionally comparable field methods where feasible and appropriate | ✓ | ✓ | ✓ |
| Establish and develop partnerships with other agencies, organizations and universities to pursue joint research projects | | ✓ | ✓ |
| By 2020, in a comprehensive water resources and management plan, collect and synthesize the following information: hydrology (seasonal water levels, wet and dry cycles, groundwater resources), water chemistry, soils, and geomorphology | | ✓ | ✓ |
| By 2013 complete baseline hydro-geomorphic study of entire Refuge (project currently funded and scheduled to begin 2011) | | ✓ | ✓ |
| Utilize trained volunteers, where feasible, to conduct surveys and collect data to reduce workload on refuge staff | | ✓ | ✓ |
| Investigate and monitor the impacts of pest plants and animals on Refuge | ✓ | ✓ | ✓ |
| Investigate movements of endangered waterbirds (e.g., inter- and intra-island movement) | ✓ | ✓ | ✓ |
| Determine survival and predation rates of endangered waterbirds | | | ✓ |
| Develop GIS layer of pest species and update on a quarterly basis | | | ✓ |
| Develop GIS layer of Refuge vegetation and update on an annual basis | | | ✓ |
| Develop climate change monitoring protocols | | | ✓ |

***Rationale:*** Monitoring projects on Refuge islands enhance scientific understanding of the ecosystems and lead to better management. Long-term monitoring efforts are extremely valuable in terms of the information provided and in adaptive management techniques. Human use issues are likely to increase in terms of pressures on the Refuge resources due to developing local and regional markets. This may lead to additional and new types of human impacts. This is likely to present management challenges, which can be approached with proactive applied research projects and long-term monitoring efforts. Communication of monitoring and research findings is the responsibility of the Service. Presentation of results and ideas helps foster the understanding and respect for Refuge management actions. Dissemination of scientific information also leads to conservation of natural resources through understanding and informed management decisions. Research presentation also provides a forum for research and management improvement through peer review.

Refuge scientists will also be encouraged to include research findings in public interpretive programs. Information on the location of extremely fragile natural resources or those subject to vandalism will not be included in final studies and reports for public distribution. Modification of databases and methods to be comparable and compatible to other research is a cost-effective way to conduct comprehensive Refuge research. Being able to compare Refuge data with other local,

regional, and even global data will help guide ecosystem management priorities for Refuge resources. It will also promote the Service‟s ecosystem approach to resource management, as well as enhance worldwide scientific connection and understanding.

During the period 2018 to 2020, a comprehensive water resources and water management plan is scheduled to be developed for the entire Refuge. This time period represents an optimum schedule for this plan for a number of reasons. Foremost is that the major milestone will be reached in 2023 when the long-term leases of the aquaculture ponds will expire and full management responsibility for these ponds will return to the Refuge. This event will have major implications across the Refuge landscape and habitat management programs. By initiating planning in 2018, we will be able to evaluate and incorporate the most recent data on a number of issues including global climate change and sea level rise, and the most up-to-date status of endangered waterbirds. A plan completed by 2020 would provide Refuge staff critical and timely information needed to make decisions about major projects related to taking over management of the aquaculture ponds which could have Refuge-wide implications and enter these projects into database needs in time to be considered by the 2023 budget cycle. A hydro-geomorphic study planned for completion by 2013 may provide much of the groundwork and provide much of the baseline information for this 2020 comprehensive plan.

### 2.6.5 Goal 5. Provide wildlife-dependent public use and educational opportunities to enhance public understanding and appreciation of the natural resources of James Campbell NWR and the Refuge System.

**Objective 5.1. Provide a quality environmental education program.**

Provide a quality EE program based on Refuge and endangered species recovery management programs, with specific learning objectives and diverse opportunities with the following attributes:

- Increases public awareness and knowledge of environmental issues;
- Meets State standards for learning;
- Provides motivation to improve or maintain environmental quality;
- Imparts skills to identify and help resolve environmental challenges; and
- With construction/staffing of an EE center, accommodates a year-round program that serves up to 6,000 students per year.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Annual Student Participation*** | 1,500 | 2000-4,000 | <6,000 |
| Develop a VSP within 5 years that identifies details of the Refuge EE program and evaluates EE facility needs, including construction of an EE center | | ✓ | ✓ |
| Promote the Refuge and the EE program with teachers during the development of the VSP | | ✓ | ✓ |
| Continue current seasonal program (October 15-February 28) at Ki„i Unit | ✓ | ✓ | |

| *Strategies Applied to Achieve Objective* | Alt A | Alt B | Alt C |
|---|---|---|---|
| Seek additional partnerships and teacher volunteers for providing additional EE opportunities annually | | ✓ | ✓ |
| Hire a permanent-full time EE specialist | | ✓ | ✓ |
| Phase-in seasonal program around Punamanō Unit as facilities are developed through the VSP (with gradual reduction at Ki„i Unit) | | ✓ | ✓ |
| Designate EE sites where students can participate in independent study | | ✓ | ✓ |
| Develop curricula for the EE program and provide support and resources for Refuge volunteers | | | ✓ |
| Expand and encourage other local schools such as Sunset Beach Elementary, Lā„ie Elementary, Kahuku Elementary, and Hau„ula Elementary to participate in educational programs | | | ✓ |
| Develop "teach the teacher" programs and Refuge-specific instructor training | | | ✓ |
| Develop grant proposals to strengthen outreach and education partnerships | | | ✓ |
| Participate in the Smaller Learning Communities Program at Kahuku schools | | | ✓ |

***Rationale:*** Environmental education does not advocate a particular viewpoint or course of action. Rather, it teaches individuals how to weigh various sides of an issue through critical thinking and it enhances their own problem-solving and decisionmaking skills. Environmental education is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action. It focuses on:

- Awareness and sensitivity about the environment and environmental challenges;
- Knowledge and understanding about the environment and environmental challenges;
- Skills to mitigate the environmental problems; and
- Participation for exercising existing knowledge and environmental related programs.

Land acquisition will expand the land base of natural resources, providing greater opportunities for year-round EE programs at James Campbell NWR. The Refuge is in a unique position to offer local education agencies, teachers, and students an opportunity to study endangered species, natural resource management, conservation issues, and cultural resources in an outdoor setting. Construction of a HQ/VC/EE facility is proposed in the vicinity of Marconi Road and Kamehameha Highway.

The Refuge currently serves 1,500 students and teachers annually. We could accommodate up to 3,000 students annually with no change in the current program. State budget issues during the 2009-2010 school year resulted in teacher furloughs, 4-day school weeks, and reduced fieldtrip funding. These issues negatively impacted the ability of teachers to bring their students to the Refuge. We

*Ki'i kiosk Laura Beauregard/USFWS*

estimate that the Refuge could accommodate up to 6,000 on-site each year if: (1) an education staff was available to run the program full-time; (2) educators were trained and could be recruited to utilize the Refuge during all months of the school year; and (3) the proposed HQ/VC/EE facility is funded and constructed.

**Objective 5.2. Offer visitors outdoor recreation opportunities to enjoy, discover, and encourage support for James Campbell NWR.**

Provide meaningful, enjoyable outdoor experiences for people of all ages (including wildlife observation, photography, interpretation, and fishing) that connect them with nature and foster a conservation ethic. By 2016, develop a VSP and associated NEPA document to identify locations, facilities, and regulations needed to provide year-round opportunities with the following attributes:

- High quality wildlife-oriented visitor experiences;
- Accessible to individuals with disabilities;
- Safe environment and facilities for visitors; and
- Visitor access to ocean shoreline is provided.

| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
|---|---|---|---|
| ***Total Annual Refuge Visitors*** | 800 | <210,000 | <210,000 |
| All Refuge units remain closed to the general public | ✓ | | |
| Maintain existing signs and interpretive material | ✓ | | |
| Conduct docent-led tours at Ki,,i Unit | ✓ | ✓ | ✓ |
| Develop a VSP within 5 years that identifies new visitor facilities and features, to include self-guided interpretive trails | | ✓ | ✓ |
| Conduct docent-led tours at Punamanō Unit, when facilities are developed through VSP | | ✓ | ✓ |
| Provide specific information for shoreline access, including ,,īlio-holo-i-ka-uaua and honu closure information in cooperation with other agencies (NOAA and State) | | ✓ | ✓ |
| Increase law enforcement presence | | ✓ | ✓ |
| Develop new interpretative materials (brochures, kiosk panels, species lists) | | ✓ | ✓ |

***Rationale:*** We see our work resulting in all visitors and local communities gaining a greater connection with nature, sense of place, respect for their environment, and a lifelong interest in and participation in the conservation, protection, and enhancement of wildlife, plants and their habitats.

A VSP will be developed to ensure: (1) opportunities exist to view wildlife in their habitat and in a natural setting; (2) observation opportunities promote public understanding of Refuge resources and its role in managing and protecting those resources; (3) observations occur in places with the least amount of disturbance to wildlife; (4) facilities are safe, fully accessible, and available to a broad spectrum of the public; (5) viewing opportunities are tied to interpretive and educational opportunities; and (6) observers have minimal conflict with other visitors or Refuge operations. Features of the VSP could address the following projects:

- Develop self-guided interpretive boardwalk with observation towers, kiosks, and spur trails for photographers and beach access (access across the Refuge will remain closed until VSP is approved and necessary infrastructure is completed);
- Design kiosks for roadside pull-offs, trail heads, and visitor contact station; and
- Work with the Hawai„i Department of Transportation and Federal Highway Administration to plan and fund safe pull-offs along Kamehameha Highway along boundary of James Campbell NWR.

The Refuge is considered by many to be one of the best areas in Hawai„i to view endangered waterbirds. High-quality wildlife viewing will continue and be expanded on the Refuge through the development and maintenance of trails, boardwalks, and observation sites (i.e., elevated viewing platforms). The up to 210,000 visitors estimate is based on having a visitor center with associated staffing.

Four species of endangered Hawaiian waterbirds are present year-round at Ki„i Unit, which currently provides the visiting public with quality viewing opportunities. Ae„o are highly susceptible to disturbance during their nesting season, whereas the other endangered waterbirds are more tolerant. Consequently, docent-led interpretative tours of Ki„i wetlands are conducted only during the ae„o nonbreeding season (October to February). During the interim between present conditions and the development of lands within the expansion boundary, these tours will be continued. As part of the VSP, we plan to develop self-guided tours in other areas of the Refuge. Once they are in place, docent-led tours will be conducted at greatly reduced frequency at Ki„i.

Refuge law enforcement officers are responsible for upholding Federal laws and regulations that protect natural resources, the public, and employees. The expansion lands come with new challenges for law enforcement on the Refuge. A dedicated Refuge Officer is needed to protect Refuge visitors and employees from disturbance or harm by others; to assist visitors in understanding Refuge laws, regulations, and the reasons for them; to enhance the management and protection of natural resources; and to obtain compliance with laws and regulations necessary for the proper administration, management, and protection of the Refuge.

## 2.6.6 Goal 6. Protect historic and cultural resources for the benefit of present and future generations.

| **Objective 6.1. Enhance awareness, protection, and appreciation of historic and cultural resources.** | | | |
|---|---|---|---|
| Throughout the life of this plan, increase monitoring, protection, and appreciation of all cultural resources and historic sites on the Refuge. Promote conservation of historic and cultural resources for the education, inspiration, and enrichment of the public in a spirit of stewardship and trusteeship for future generations. | | | |
| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
| Comply with Section 106 of the National Historic Preservation Act (NHPA) when conducting ground-disturbing activities | ✓ | ✓ | ✓ |
| Develop and maintain liaison with Native Hawaiian organizations | ✓ | ✓ | ✓ |
| Consult with Native Hawaiian groups, historical societies, and other preservation partners to identify types of historic and cultural resource information appropriate for public interpretation | ✓ | ✓ | ✓ |
| Train all field personnel in Native American Grave Protection and Repatriation Act (NAGPRA) protocol and procedures for handling inadvertent discoveries of human remains and cultural artifacts | | ✓ | ✓ |
| Develop a Refuge GIS layer for cultural resource sites (for use in management decisions, with sensitive information protected) | | | ✓ |
| Develop a GIS layer for World War II remnants on Refuge lands | | | ✓ |

***Rationale:*** The NAGPRA is a Federal law that provides, in part, a process for Federal agencies to transfer custody and control of certain Native American cultural items (human remains, funerary objects, sacred objects, and objects of cultural patrimony) removed from Federal lands to lineal descendants, Indian tribes, and Native Hawaiian organizations. Native Hawaiians believe that the mana or spiritual essence and power of a person reside in the bones, their iwi. Unmarked Native Hawaiian burial sites have been exposed in the coastal strand/dunes area of the Refuge but can be encountered almost anywhere. Care of inadvertently discovered iwi kupuna (ancient bones) is an important issue for Native Hawaiians and the entire community in Hawai,,i. The Service has the responsibility to care for the iwi kupuna with utmost respect for Hawaiian protocol and the recognized lineal descendants and culturally affiliated Native Hawaiian organizations. Strict protocols come into force whenever human skeletal remains are encountered inadvertently, through maintenance activities or through natural erosion.

When remains are encountered, all work in the immediate area is stopped, and the police as well as the Coroner/Medical Examiner are notified. If the remains appear to be under 50 years in age, a possible homicide victim, or missing person, the local police secure the scene and investigate. If the remains appear to be over 50 years in age since death and interment, a qualified archaeologist then examines the burial context to assist in determining whether they may be iwi kupuna. If they are iwi kupuna, the

Service, in consultation with recognized descendants or Native Hawaiian organizations, determines whether the burial can safely remain in place where discovered or whether relocation may be needed.

The key to protecting cultural resources is promoting knowledge of and appreciation for the resources. Currently, information on known cultural sites is not easily accessible to Refuge field staff responsible for the maintenance operations. Recognizing that sensitive information should be protected, knowledge of specific areas to avoid would be helpful to field staff engaging in maintenance activities around the Refuge. James Campbell NWR had a cultural resource overview completed by the National Park Service in 2005. However, a comprehensive access-protected GIS-based database is needed. The Zone Officer has received training in cultural resource law, but continuing education and coordination with State officers is needed for more staff.

Polynesian settlement, Hawaiian legends, agricultural activities, and World War II fortifications are all part of the rich history within the Refuge, and it is appropriate to share these stories with the public. The Refuge could achieve a higher level of interpretation by partnering with Native Hawaiians and groups interested in local history. Protection of historic and cultural resources will be incorporated in the VSP.

*Kahuku Airfield, August 20, 1942 / DOD archives*

## 2.6.7 Goal 7. Assist partner agencies and local community with planning and implementing flood damage control measures for the Town of Kahuku.

| **Objective 7.1. Support flood damage reduction efforts for Kahuku.** | | | |
|---|---|---|---|
| Maintain floodwater storage function of Refuge expansion lands (when fully acquired) and support approved watershed flood control projects. | | | |
| ***Strategies Applied to Achieve Objective*** | **Alt A** | **Alt B** | **Alt C** |
| Cooperate in planning process for future proposed flood control project(s) that may utilize portions of Refuge expansion lands | ✓ | ✓ | ✓ |
| Maintain 73-ac. Walkerville Unit (when fully acquired) as potential flood damage reduction project area by:<br>• Periodic disking or mowing to prevent further encroachment by woody vegetation and allow more free-flowing water;<br>• Removing existing encroaching woody vegetation, as feasible;<br>• Participating in community and government planning efforts to reduce flood damages in Kahuku; and<br>• Continuing to regularly maintain Refuge ditches. | | ✓ | ✓ |

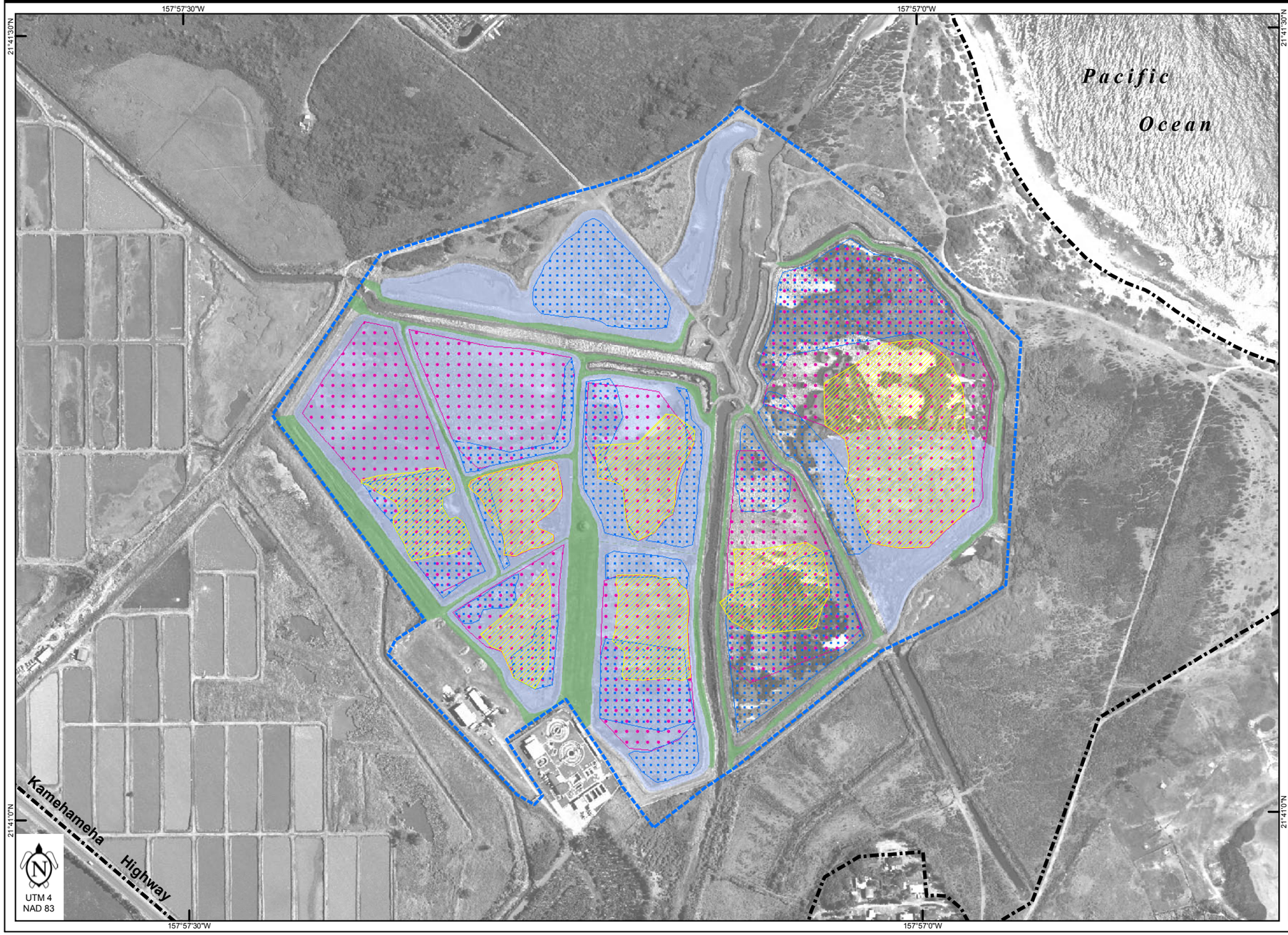
***Rationale:*** Local flooding following major rainfall is an important concern for the local Kahuku community. Past flooding has damaged homes and businesses and closed local roads and highways. Portions of the Refuge expansion lands lie within the floodplain and floodway adjacent to the town of Kahuku and Hospital Ditch, a vital local drainage. These lands already flood following heavy rain and runoff but have been identified as a site where engineered (controlled) flooding may offer some opportunity for flood damage reduction in the surrounding area. As identified in studies by the U.S. Army Corps of Engineers (USACE), flooding in the local area has many causes and contributing factors. Future projects will likely not completely solve this problem but may help to mitigate (reduce) damages under certain conditions.

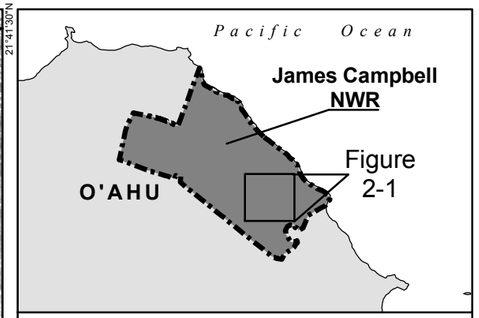
The proposed Walkerville Unit is well suited for potential flood mitigation projects because of its proximity to Kahuku and major drainage ditches, its relatively low-lying elevation and lower overall potential wildlife value than other Refuge expansion lands. This area is comprised primarily of former agricultural lands that have been unused for several years. As a result, much of the area is heavily encroached by woody pest vegetation which can hamper the flow of floodwater. Planned disking and mowing will prevent further encroachment and can be seasonally timed to provide short vegetation or open ground which can benefit some species of endangered or migratory birds.

This designation of the Walkerville Unit is intended only as an interim measure until final decisions regarding such projects are made. Also, other adjoining Refuge expansion lands (primarily makai) may still also be considered in future flood mitigation projects and are not excluded. All potential projects would be subject to full engineering, environmental, and regulatory evaluations and compliance.

*[Note to readers: As of June 2011, the parcel of land containing this proposed unit has not been acquired by the Service.]*

**Figure 2-1a.** **James Campbell NWR**




**Alternative A**
**Habitat Management**

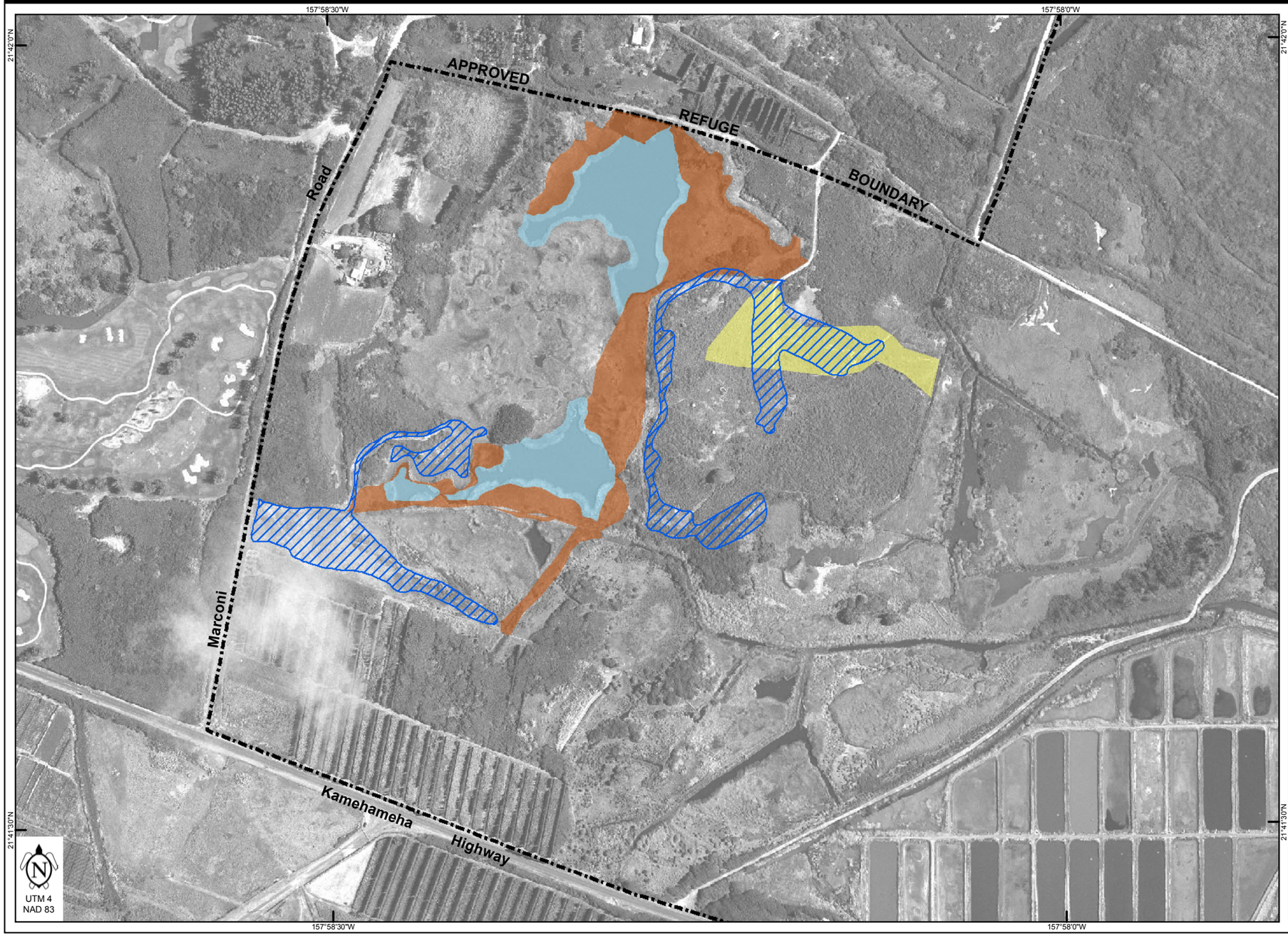
**Ki'i Unit**

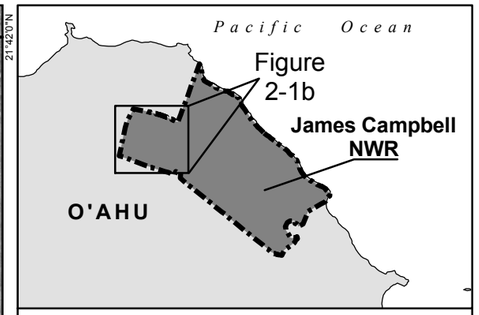
- Ae'o Loafing & Foraging
- Ae'o, 'Alaeke'oke'o, & 'Alae'ula Loafing & Foraging - Dikes
- 'Alaeke'oke'o & 'Alae'ula Loafing & Foraging
- 'Alaeke'oke'o & 'Alae'ula Breeding
- Ae'o Breeding
- Intensively Managed Wetland Boundary
- Approved Acquisition Boundary

Feet
0 400 800
0 100 200
Meters

5-2-11; 10-053-15.MXD

**Figure 2-1b.** **James Campbell NWR**




**Alternative A**
**Habitat Management**

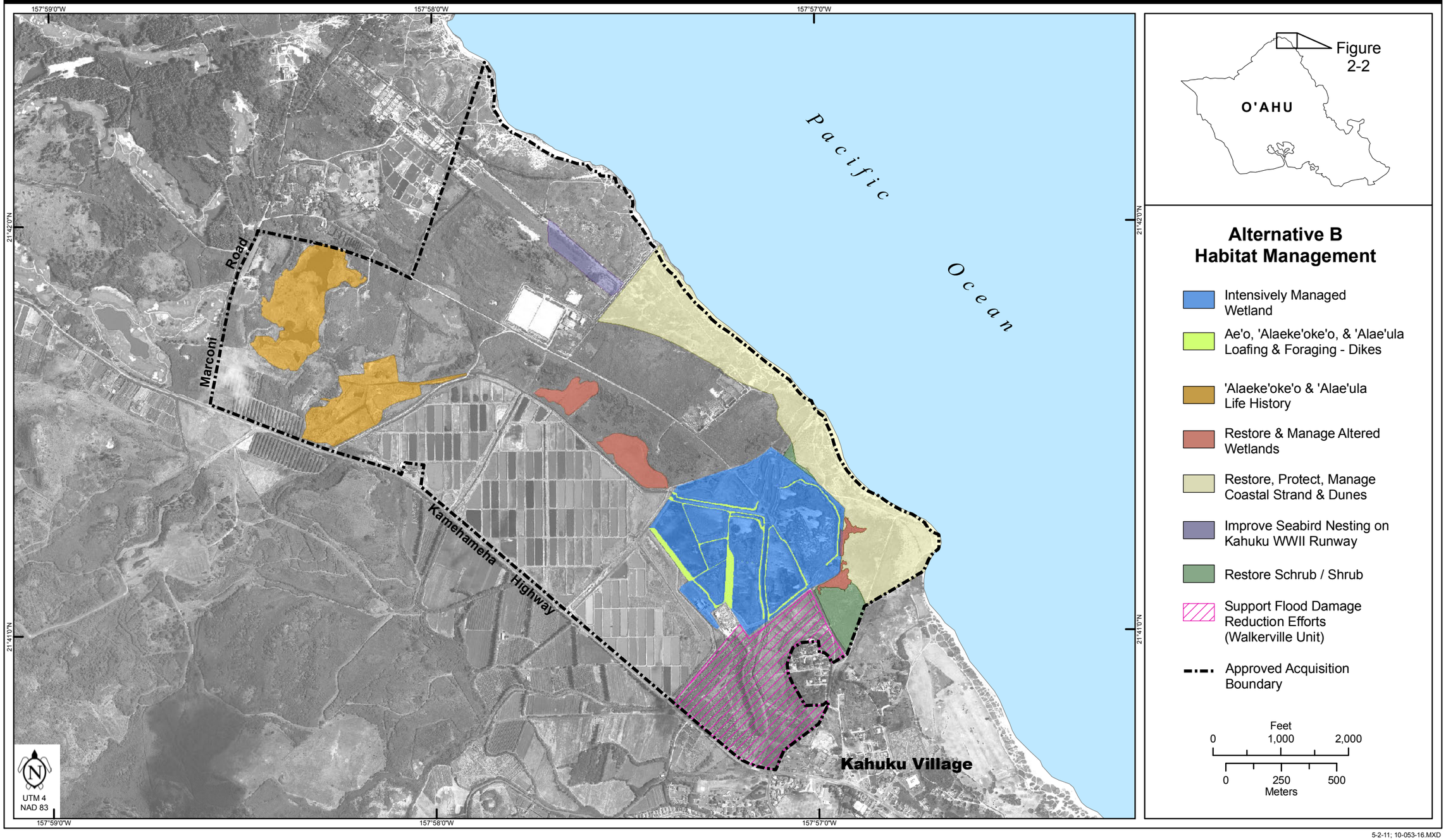
**Punamano Unit**

- Ae'o & Alae'ula Foraging - Grasslands
- 'Alaeke'oke'o & 'Alae'ula Breeding & Foraging - Open Water
- NAWCA Bullrush Removal Area
- Restoration Area - Mowed Grassland
- Approved Acquisition Boundary

Feet
0 400 800
0 100 200
Meters

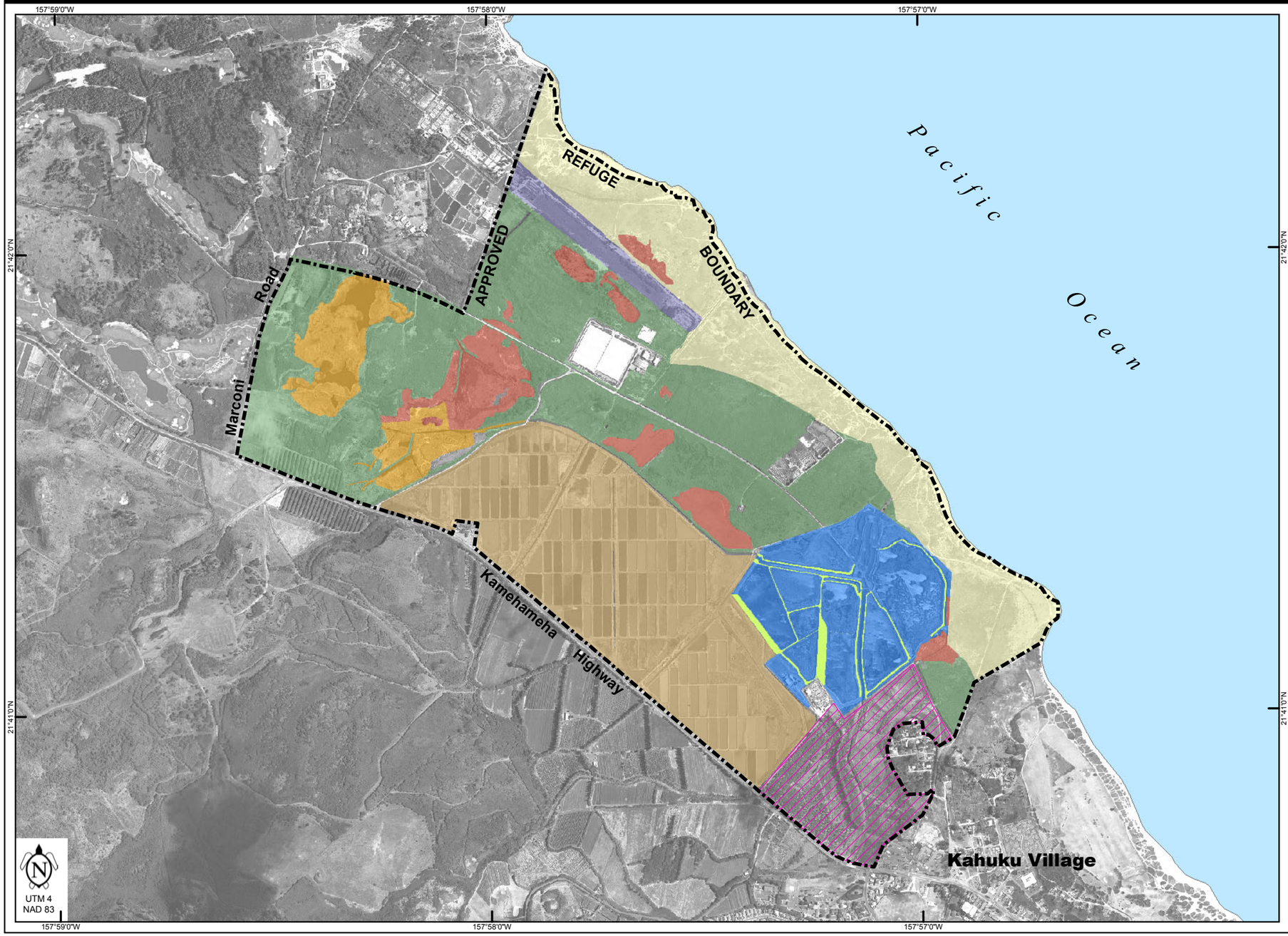
5-16-11; 10-053-18.MXD

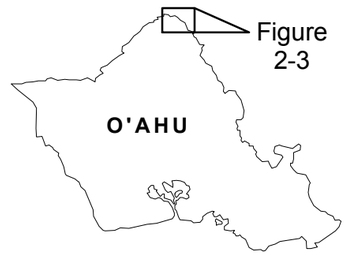
**Figure 2-2.** **James Campbell NWR**




5-2-11; 10-053-16.MXD

**Figure 2-3.** **James Campbell NWR**




**Alternative C Habitat Management**

- Intensively Managed Wetland
- Ae'o, 'Alaeke'oke'o, & 'Alae'ula Loafing & Foraging - Dikes
- 'Alaeke'oke'o & 'Alae'ula Life History
- Restore Altered Wetlands for Water & Migratory Birds
- Restore, Protect, Manage Coastal Strand & Dunes
- Improve Seabird Nesting on Kahuku WWII Runway
- Restore Schrub / Shrub
- Aquaculture Leases
- Support Flood Damage Reduction Efforts (Walkerville Unit)

Feet
0 1,000 2,000
0 250 500
Meters

5-2-11; 10-053-17.MXD

# Chapter 3. Physical Environment

## 3.1 Refuge Introduction

The O,,ahu National Wildlife Refuge Complex (Complex) is located on the Island of O,,ahu, within the State of Hawai,,i. The Complex consists of James Campbell NWR, Pearl Harbor NWR, and O,,ahu Forest NWR. Management of the Complex is conducted from the Service office located in Hale,,iwa on the north shore of O,,ahu (Figure 3-1). This CCP focuses on the James Campbell NWR.

James Campbell NWR is located on the northeastern coast of O,,ahu near the community of Kahuku. As of March 2011, the Service owns 934 acres of habitat, including permanent, seasonal, and ephemeral wetlands, shrublands, coastal strand, sand dunes, and aquaculture ponds under lease from the Service. An additional 151 acres are in the process of acquisition within the approved boundary.

## 3.2 Climate

Located 2,400 miles southwest of the nearest continental landmass, the Hawaiian Islands are the most isolated archipelago in the world. The climate of Hawai,,i is generally constant throughout the year, with only minor periods of diurnal and seasonal variability. During the summer season (May-September), temperatures are slightly warmer, conditions are drier, and trade winds originate from the northeast. The winter season (October to April) is characterized by cooler temperatures, higher precipitation, and gustier winds. The trade winds also produce differences within the two physiographic provinces. On the windward or northeastern side of O,,ahu, climatic conditions are relatively wet and strongly influenced by patterns of orographic rainfall. The leeward areas in the southern and western portion of the island experience decreased winds, less rain, and are subject to southerly Kona storms (Juvik and Juvik 1998).

O,,ahu climate is influenced by three interacting climatic factors: (1) the Hadley cell, (2) the oceanic position of the major Hawaiian Islands, and (3) topography. The Hadley cell is a system of atmospheric circulation that is propelled by warm air rising near the equator and cool sinking air in the subtropics. In the Northern Hemisphere, air flowing within this system is reflected by the Earth"s rotation to create northeasterly winds referred to as trade winds. Wind patterns, rainfall distribution, and other climatic conditions are also affected by the geographic location of Hawai,,i (Juvik and Juvik 1998, Lau and Mink 2006).

Trade winds in Hawai,,i originate from a high-pressure system located northeast of the archipelago called the North Pacific anticyclone. During the summer season, this system is stable and trade winds occur 80 to 95 percent of the time (Oki 2005). This high-pressure cell further regulates Hawai,,i"s climate because it shifts seasonally, causing trade wind and precipitation differences. During the winter and spring season, the North Pacific anticyclone moves further south and weakens, causing less persistent trade winds (50 to 80 percent of the time) and a greater chance of storms (Lau and Mink 2006).

Furthermore, the varied topography of the island affects the climate. The alignment, shape, and height of the mountains moderate wind patterns and cause moist air to rise near the mountain ranges. Excess clouds accumulate near mountain peaks and enhance precipitation amounts, referred to as

orographic rainfall (Juvik and Juvik 1998, Lau and Mink 2006). The coastal, leeward sides of the mountains receive less precipitation because the air loses moisture as it ascends the windward side (Oki 2005).

Prevailing ocean currents influence weather patterns by moderating the surrounding surface air temperatures (as a result of differential heat adsorption and advection of heat). Ocean currents around the Hawaiian Islands are moderated by the North Pacific anticyclone, a clockwise gyre that extends from the tropics to the North Pacific. The east to west flowing North Equatorial Current splits at the Island of Hawai„i, creating a northern branch current that is 65 miles wide. Ocean surface water temperatures surrounding O„ahu range from a mean of 75°F from February to April, to about 81°F between August and October (Juvik and Juvik 1998, Lau and Mink 2006).

Located near the community of Kahuku, the Refuge has a climate characteristic of lowland areas on the windward side of O„ahu. Annual temperatures on the Refuge range from 68.9 to 80.8°F. Annual precipitation in James Campbell NWR is between 26 and 28 inches. Evaporation rates in the area are dependent on cloud cover and rainfall (Hunt and De Carlo 2000, DBEDT 2007).

Due to its location on the northern tip of O„ahu, Kahuku is considered a high wind energy site. Wind speed ranges from 14.5 to 16.8 mph, with increasing speed on the northern portion of the Refuge. The prevailing northeasterly trade winds are present nearly 90 percent of the year in Kahuku and the southerly Kona winds are present approximately 10 percent of the year. On the northern coast of O„ahu, the average humidity is roughly 74.6 percent, with slight seasonal variation (Group 70 Limited 1989, HECO 2004, Lau and Mink 2006).

*Kahuku Wind turbines generate power adjacent to Refuge George Fisher/USFWS*

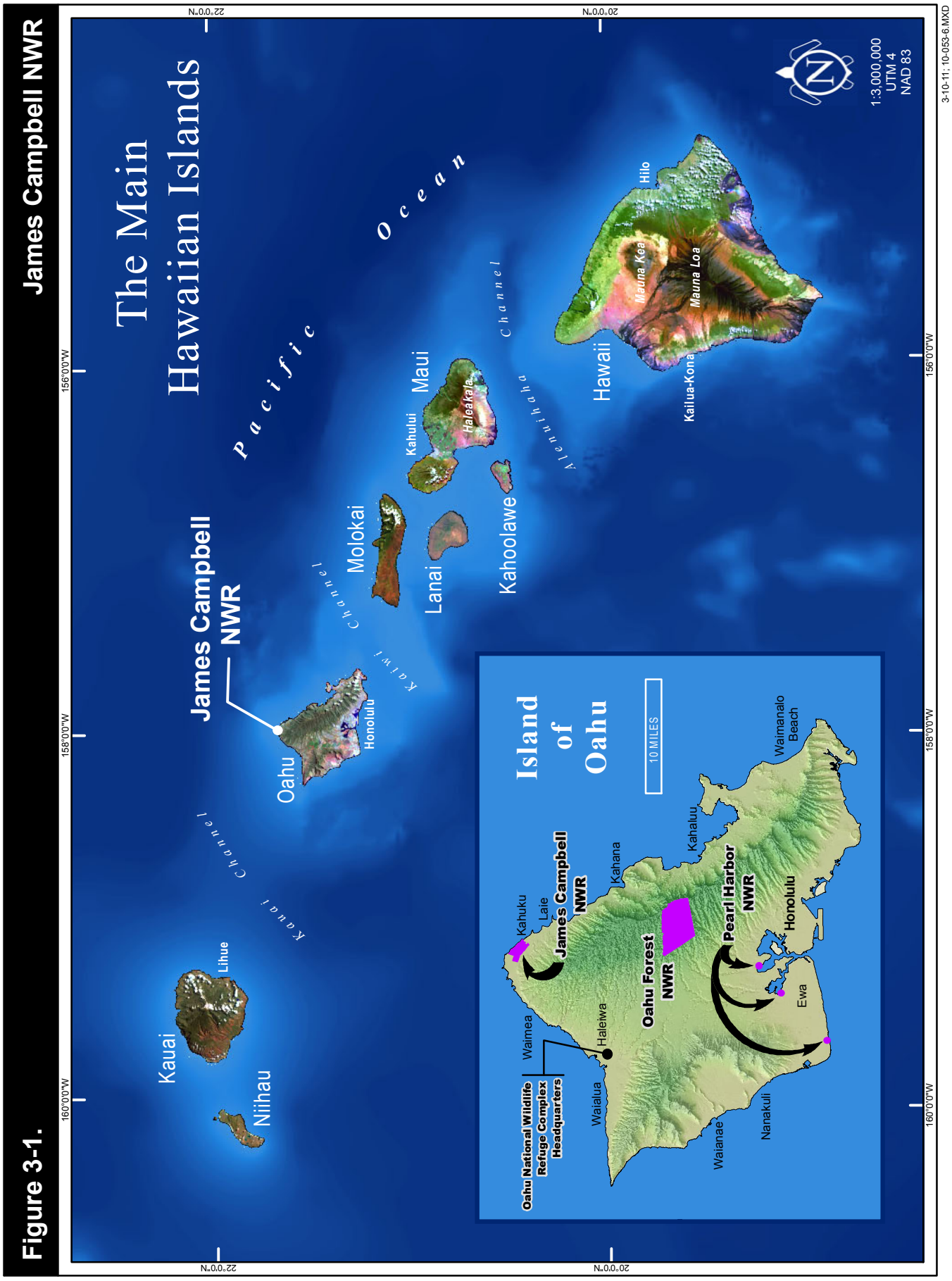

James Campbell NWR
The Main Hawaiian Islands
Pacific Ocean
James Campbell NWR
Oahu
Honolulu
Kauai
Lihue
Niihau
Molokai
Lanai
Kahoolawe
Maui
Kahului
Haleakala
Hawaii
Hilo
Mauna Kea
Mauna Loa
Kailua-Kona
Island of Oahu
10 MILES
Oahu National Wildlife Refuge Complex Headquarters
Waimea
Haleiwa
Waialua
Kahuku
Laie
James Campbell NWR
Kahana
Kahaluu
Oahu Forest NWR
Pearl Harbor NWR
Honolulu
Ewa
Waianae
Nanakuli
Waimanalo Beach
1:3,000,000
UTM 4
NAD 83
3-10-11; 10-053-6.MXD

Figure 3-1.

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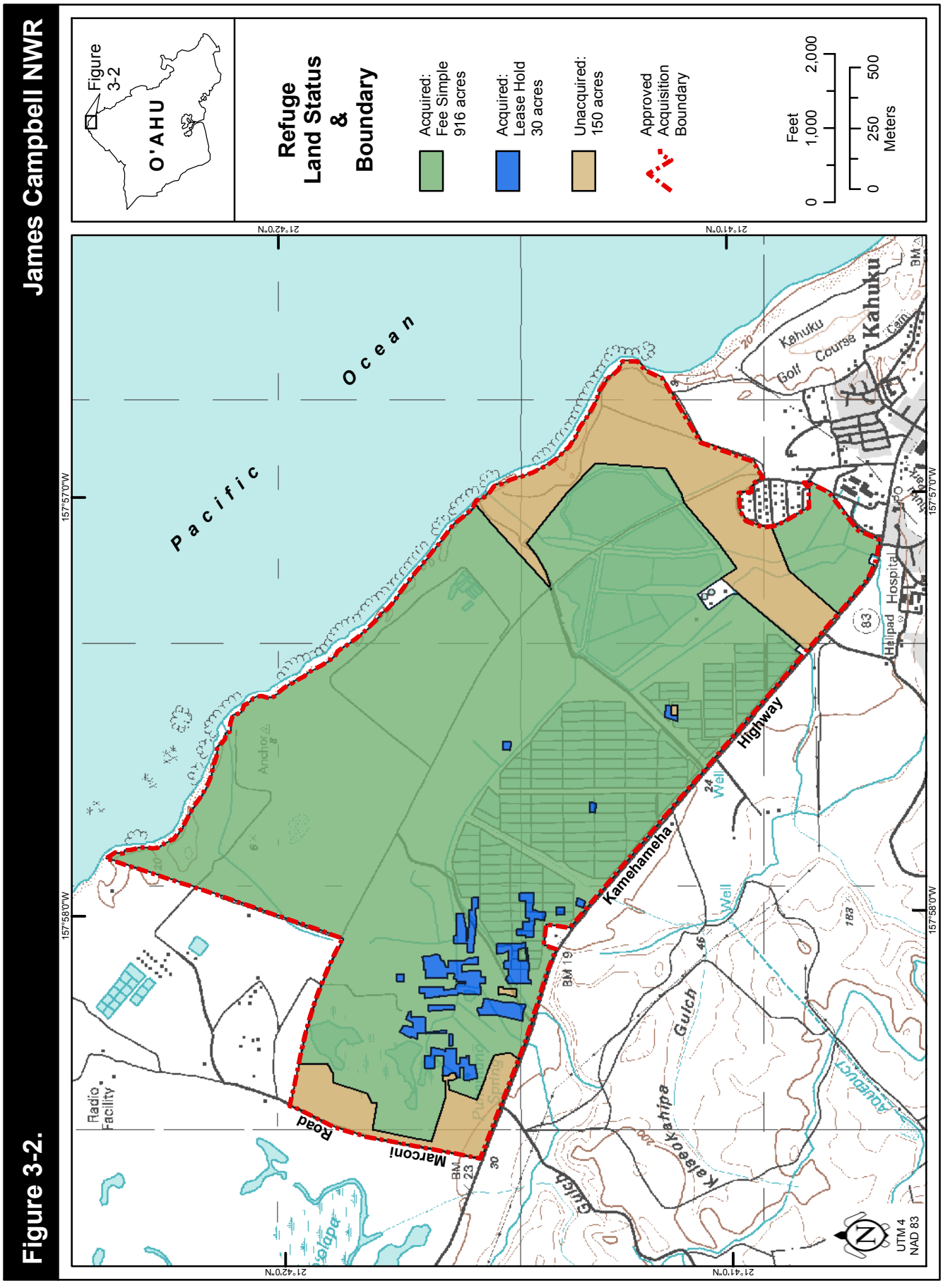
James Campbell NWR
Figure 3-2.
Figure 3-2
O'AHU
Refuge Land Status & Boundary
Acquired: Fee Simple 916 acres
Acquired: Lease Hold 30 acres
Unacquired: 150 acres
Approved Acquisition Boundary
Feet 0 1,000 2,000
Meters 0 250 500
2-2-11; 10-053-1.MXD
Pacific Ocean
Kahuku
Kahuku Golf Course
Hospital
Helipad
Highway
Kamehameha
Well
Gulch
Aqueduct
Marconi Road
Radio Facility
Anchor
BM 19
BM 23
157°57'0"W
157°58'0"W
21°42'0"N
21°41'0"N
UTM 4
NAD 83

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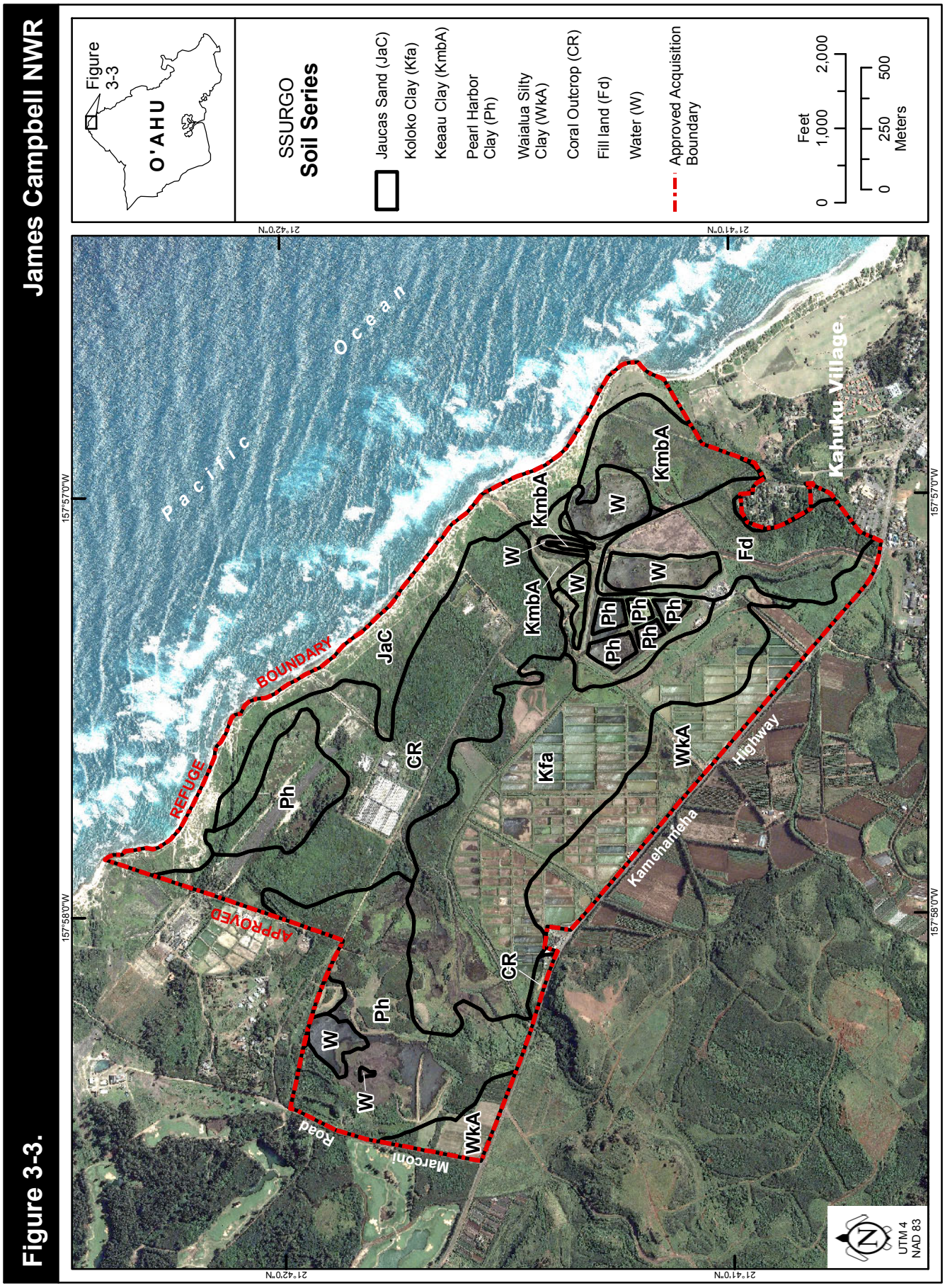
James Campbell NWR
Figure 3-3.
Figure 3-3
O'AHU
SSURGO
Soil Series
Jaucas Sand (JaC)
Koloko Clay (Kfa)
Keaau Clay (KmbA)
Pearl Harbor Clay (Ph)
Waialua Silty Clay (WkA)
Coral Outcrop (CR)
Fill land (Fd)
Water (W)
Approved Acquisition Boundary
Feet
0
1,000
2,000
Meters
0
250
500
1-24-10; 10-053-9.MXD
Pacific Ocean
Kahuku Village
Kamehameha Highway
Marconi Road
REFUGE BOUNDARY
APPROVED
JaC
CR
Ph
Kfa
KmbA
WkA
W
Fd
157°57'0"W
157°58'0"W
21°42'0"N
21°41'0"N
UTM 4
NAD 83

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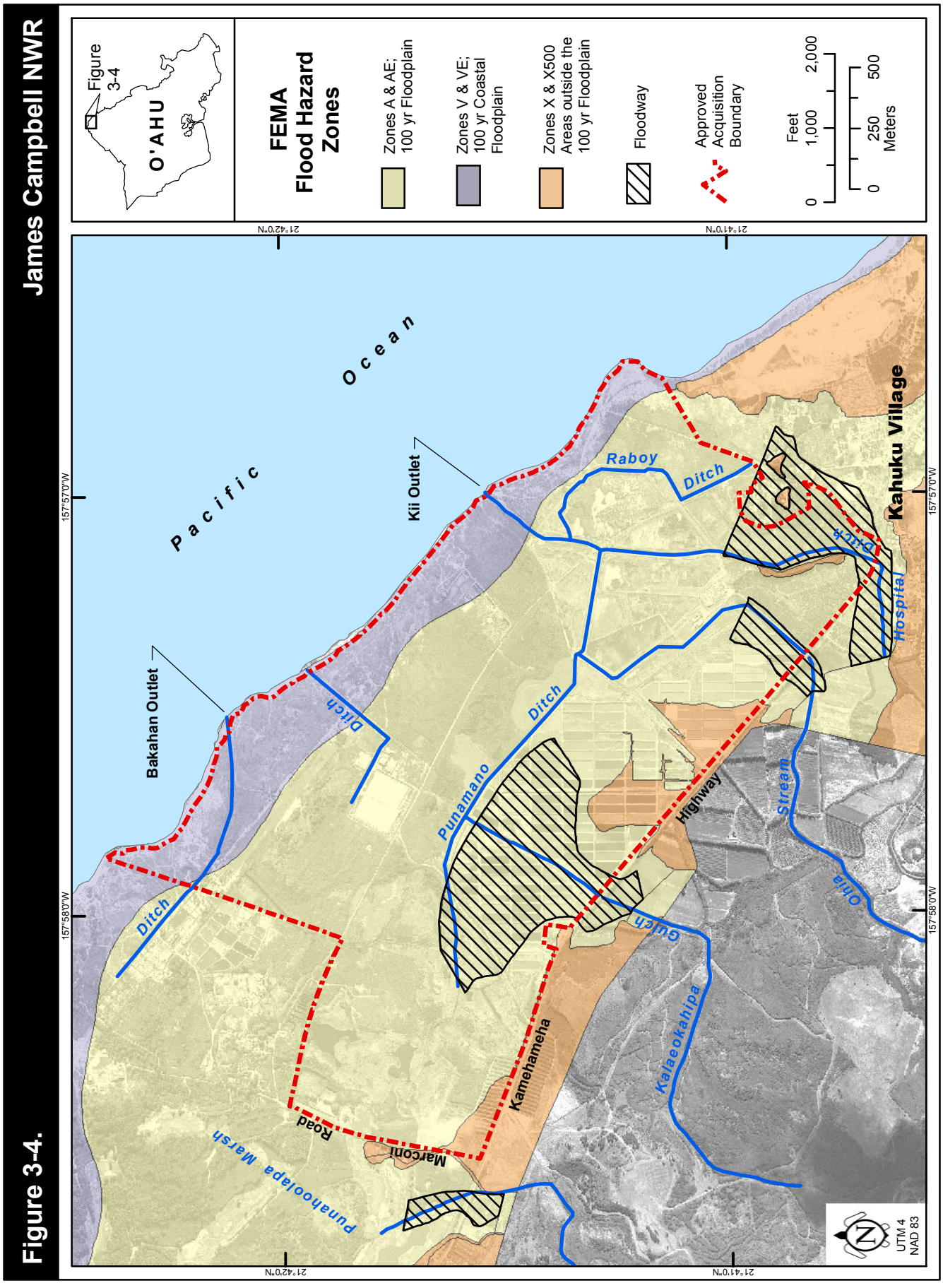
James Campbell NWR
Figure 3-4.
Figure 3-4
O'AHU
FEMA Flood Hazard Zones
Zones A & AE; 100 yr Floodplain
Zones V & VE; 100 yr Coastal Floodplain
Zones X & X500 Areas outside the 100 yr Floodplain
Floodway
Approved Acquisition Boundary
Feet 0 1,000 2,000
Meters 0 250 500
1-24-11; 10-053-3.MXD
Pacific Ocean
Kii Outlet
Bakahan Outlet
Raboy Ditch
Ditch
Punamano Ditch
Ditch
Ditch
Kahuku Village
Hospital
Highway
Stream
Ohia
Gulch
Kalaeokahipa
Kamehameha
Marconi Road
Punahoolapa Marsh
157°57'0"W
157°58'0"W
21°42'0"N
21°41'0"N
UTM 4
NAD 83

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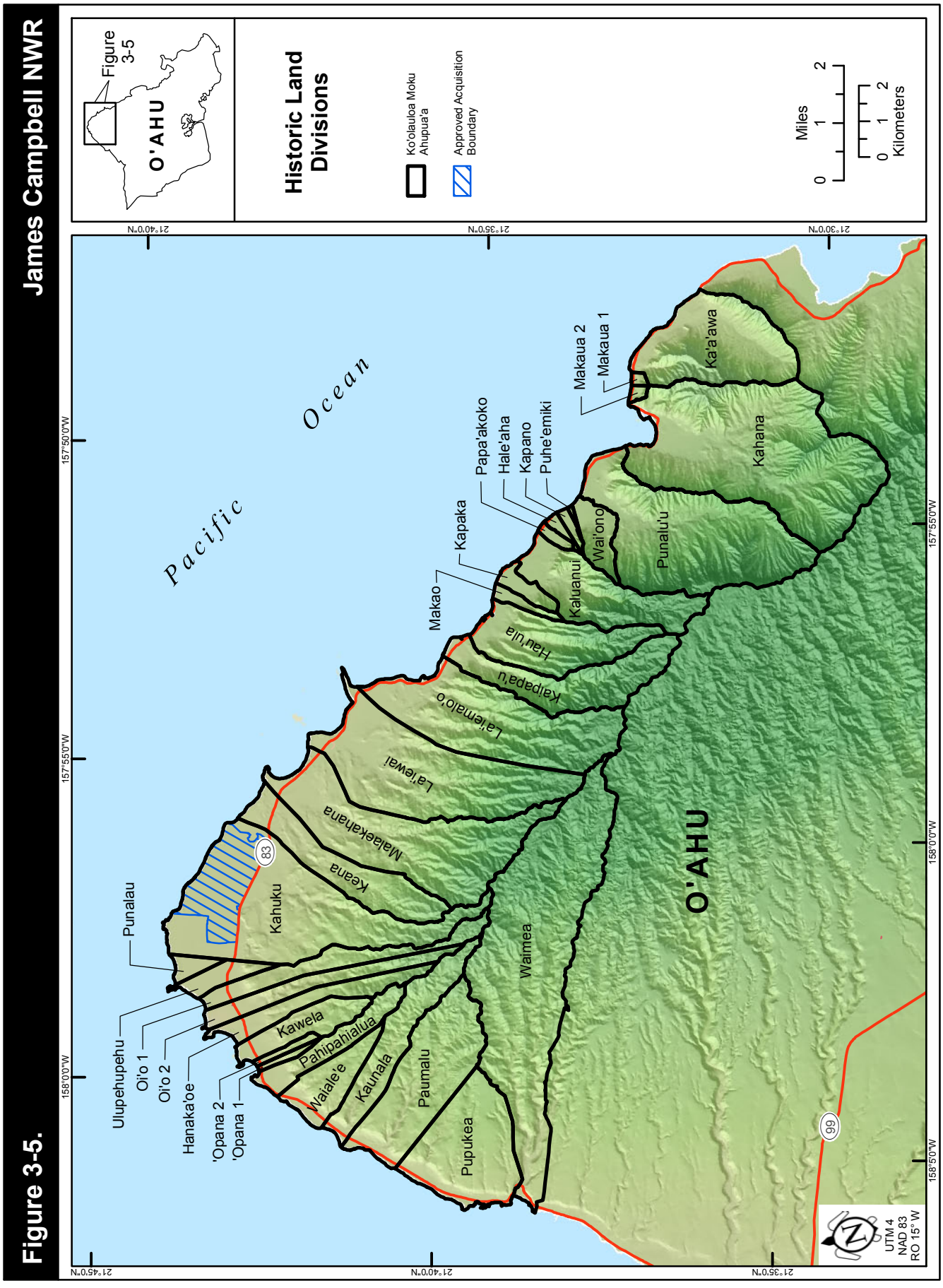
James Campbell NWR
Figure 3-5.
Figure 3-5
O'AHU
Historic Land Divisions
Ko'olauloa Moku Ahupua'a
Approved Acquisition Boundary
Miles
0 1 2
Kilometers
0 1 2
1-24-11; 10-053-13.MXD
Pacific Ocean
O'AHU
Punalau
Kahuku
Keana
Malaekahana
La'iewai
La'iemalo'o
Kaipapa'u
Hau'ula
Makao
Kapaka
Papa'akoko
Hale'aha
Kapano
Puhe'emiki
Makaua 2
Makaua 1
Ka'a'awa
Kahana
Punalu'u
Kaluanui
Wai'ono
Waimea
Pupukea
Paumalu
Kaunala
Waiale'e
Pahipahialua
Kawela
'Opana 1
'Opana 2
Hanaka'oe
Oi'o 2
Oi'o 1
Ulupehupehu
83
99
158°0'0"W
157°55'0"W
157°50'0"W
158°5'0"W
21°45'0"N
21°40'0"N
21°35'0"N
21°30'0"N
UTM 4
NAD 83
RO 15° W

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## 3.3 Geology and Soils

The Hawaiian Islands were formed by a series of volcanic eruptions that occurred at hotspots beneath the Earth's crust. As the tectonic plate slowly drifted, magma welled up from fixed spots creating a linear chain of islands. O,,ahu is the third-largest island in the chain and encompasses a total land area of 597.1 square miles. The island is mostly composed of the heavily eroded remnants of two large Pliocene shield volcanoes that broke the surface of the Pacific Ocean at different times and continued building to eventually form a single island. The western Wai,,anae volcano is approximately 2.7 to 3.4 million years old. It consists of shield lavas overlain by a thick sequence of post-shield alkalic basalt. The Ko,,olau Volcano on the east formed about 2.2-2.5 million years ago and is comprised of shield lavas, referred to as Ko,,olau Basalt, as well as rejuvenated stages, termed the Honolulu Volcanics. The sea level around O,,ahu has repeatedly fluctuated during various glacial epochs. During a period of higher sea level, a coral reef platform developed around the perimeter of the island. This platform currently makes up the island's shoreline (Juvik and Juvik 1998).

Soils on O,,ahu were classified by the U.S. Department of Agriculture (USDA) Soil Conservation Service. Soils and sediments on low-lying areas of O,,ahu have been influenced primarily by periods of changing sea levels and human modifications (Juvik and Juvik 1998).

The Kahuku area of O,,ahu has a complex geological history. Eroded shield volcanoes, such as the Ko,,olau Volcano, typically have dike complexes of basaltic material associated with active rift zones. These massive sheets of rock extend vertically into the lava flows, inhibiting normal groundwater flow. The Kahuku coastal plain is underlain by marine sediments and basaltic alluvium that has eroded from the Ko,,olau Mountains. Two alluvial fans, or fan shaped deposits, unfold on the coastal plain near the Refuge as a result of stream deposition (Hunt 1996, Hunt and De Carlo 2000).

The ponds at the Punamanō and Ki,,i Units are underlain with black, organic-rich mud that is several feet thick (Hunt and De Carlo 2000). According to the Soil Conservation Service, the following soil classifications are found within the Refuge:

*Jaucas sand, 0-15 percent slopes (JaC):* This sandy soil is single grain, pale brown to very pale brown, with a depth of more than 30 inches. Due to the accumulation of organic matter and alluvium, the surface layer may be dark brown. Narrow strips of beaches, as well as Pūlehu, Mokulē,,ia, and Kea,,au soils may also be present. The soil is neutral to moderately alkaline and in general the slope does not exceed 7 percent. Jaucas sand has rapid permeability and runoff is very slow to slow. Because the soil is loose, wind erosion is a severe hazard in areas without vegetation. Water erosion is considered a slight hazard (Foote et al. 1972).

*Kea'au clay, saline, 0-2 percent slopes (KmbA):* Found on the coastal plains of O,,ahu, this soil occurs in depressions near the ocean or in limestone pockets. The surface layer is very dark grayish-brown clay with a platy or vesicular structure. The subsoil is very dark grayish-brown and dark-brown, mottled clay. This soil is unique in the Kea,,au series because it is strongly affected by salts. Areas underlain by Kea,,au clay are often drained or filled for various uses (Foote et al. 1972).

*Fill land (Fd):* This classification includes areas filled with bagasse and slurry from sugar mills, as well as material from dredging and soil excavations (Foote et al. 1972).

*Waialua silty clay (WkA):* Characteristics of this soil type are: moderate permeability; slow runoff; slight erosion hazard; roots penetrate to a depth of 5 feet or more in places; surface soils are 12 inches thick, subsoil about 26 inches thick; shrink-swell potential is moderate (Foot et al. 1972).

*Kaloko clay, noncalcareous variant (Kfb):* The noncalcareous variant of the Kaloko series occurs in slight depressions on the coastal plains of O,,ahu. More acidic and grayer than the other soils in the Kaloko series, this soil is underlain by noncalcareous material. The surface layer is very dark gray clay, while the subsoil is gray or grayish-brown prismatic clay. The substratum is massive clay and silty clay. Small areas of very deep, well-drained alluvial soils were also identified in drainage ways. The permeability of this soil is ranked as slow, runoff is very slow, and the erosion hazard is none to slight (Foote et al. 1972).

*Coral outcrop (CR):* Coral outcrop, which is comprised of coral or cemented calcareous sand, can be found on O,,ahu between 0-100 feet in elevation. It is geographically associated with Jaucas, Kea,,au, and Mokulē,,ia soils. Within the cracks, crevices, and depressions of the coral outcrop, a thin layer of friable, red soil material can be found. Sparse vegetation typically grows in coral outcrop (Foote et al. 1972).

*Beaches (BS):* This land type consists of light-colored sands derived from coral and seashells (Foote et al. 1972).

## 3.4 Hydrology

The hydrologic processes that occur in the Hawaiian Islands are unique compared to continental landmasses or temperate zones. Drainage basins are typically small and streams are characterized by steep longitudinal profiles and numerous waterfalls. The Island of O,,ahu has 57 perennial streams. Stream flow depends on the climatic and geological features of the area. For example, some streams on O,,ahu have lengthy dry reaches under natural conditions due to permeable underlying rock. O,,ahu also has a vast amount of groundwater, which supplies most of the domestic water supply (Lau and Mink 2006).

The combination of intense storms, steep terrain, and urban land uses causes flooding in certain areas of O,,ahu. The Flood Insurance Rate Maps (FIRM) prepared by the Federal Emergency Management Agency‘s National Flood Insurance Program depict flood hazard areas throughout the State. The maps classify land within the Refuge boundary into four zones depending on the expectation of flood inundation (Figure 3-4).

The Kahuku basin, which drains approximately 7.6 square miles, ranges in elevation from 0-1,800 feet on the northern slopes of the Ko,,olau Mountains. This basin also includes a 3.2-square mile low-lying coastal floodplain. Streams in the Kahuku area are typically short and steep, causing periods of high peak floods. ,,Ōhi,,a, Kalaeokahipa, and Ho,,olapa are intermittent streams in the Kahuku area (Smith, Young & Assoc. 1990, Hunt and De Carlo 2000).

Groundwater in the Kahuku area primarily occurs as a basal freshwater lens in the dike-free Ko,,olau Basalt and overlying unconsolidated and consolidated sedimentary deposits. This aquifer extends from Punalu,,u Valley to Kahuku Point. Groundwater levels in the region vary between 7-20 feet above mean sea level, with lower levels near the shore. Regionally, groundwater moves from the

volcanic-rock aquifers into the overlying sedimentary deposits and eventually discharges to the ocean. Flow to the ocean is estimated from 2-4 mgd per mile of shoreline, depending on rock permeability. Mean annual groundwater recharge due to rainfall infiltration is approximately 3.8 mgd. Additional recharge occurs as a result of inflow from the adjacent dike complex. Historically, aquifers were heavily developed for agriculture in this region; however, when sugarcane cultivation ceased in 1971, estimated water use declined significantly (Mink 1982, Smith, Young & Assoc. 1990, Miller et al. 1999).

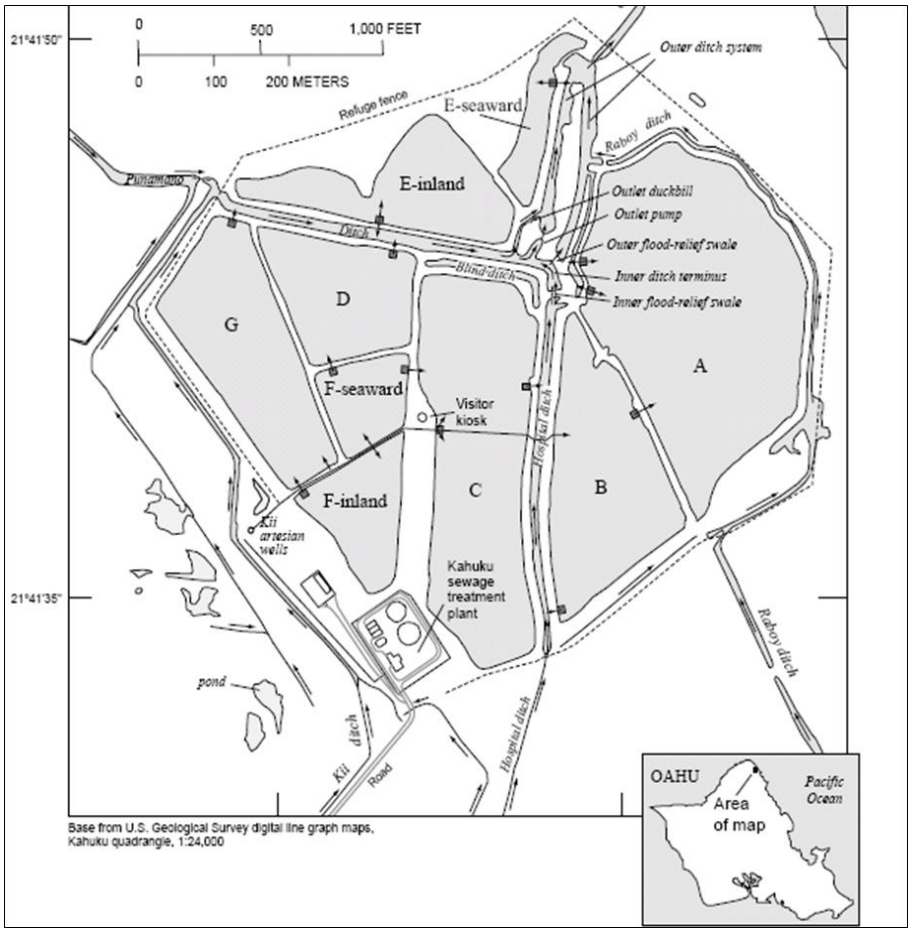
Naturally occurring wetlands are situated along the coastal Kahuku plain. The Ki„i Unit of the Refuge is a remnant of a formerly larger marsh that has been drastically modified by agriculture. In 1976, the Service began to supply the assemblage of ponds with water from adjacent ditches and artesian wells. There are a total of seven ponds (identified as Ponds A-G) within the Ki„i Unit, which are separated from each other by earthen berms or levees (Figure 3.6). Pond water levels generally average between 3-4.5 feet. The most seaward ponds (Ponds A and E) typically maintain lower water levels, between 1.5-3 feet. Water levels in the adjacent ditch system are lower than the pond levels, averaging 2 feet. The pH levels range between 6.95 and 8.15 (Hunt and De Carlo 2000). According to Hunt and De Carlo, the drainage area for the Ki„i Unit is approximately 3.87 square miles. These subwatershed areas, in decreasing size, include „Ōhi‘a Ai Gulch, Kalaeokahipa Gulch, Hospital ditch, and runoff from a residential subdivision.

Ground water inflows do not substantially contribute to the ponds; rather, the primary water source for the ponds is a single 12-inch artesian well that is connected to a 12-inch distribution system. Since 2001, the average water temperature and salinity of the water in the well has been 72.5°F and 0.41 ppt, respectively. Pipelines feed water into ponds G, F, C, and B. Subsequently, water is fed to ponds D and A through control structures in ponds F and B, respectively. Pond E is not supplied by water from the well, but is fed by control structures connected to the ditches. Direct rainfall supplements water provided by the well. During periods of heavy precipitation, control values are manually adjusted to regulate the amount of water distributed into each pond. The well is turned off during excessively high rain periods to prevent flooding. The Refuge is currently allotted 1 mgd. Prior to July 2004, the Refuge utilized three 3-inch diameter artesian wells, which piped water into the seven impoundments. Use has ceased, but the wells remain onsite.

An abandoned ditch system drains the seaward Kahuku coastal plain. Within the Ki„i Unit, several ditches can be found including the Hospital ditch, the Punamanō ditch, the Ki„i ditch, and the Raboy ditch. An outlet ditch then discharges this water to the ocean. Five of the seven ponds dump into the ditch system. Water from the adjacent ditch systems is not used as a supplemental water source for the ponds due to concern of contamination on upland properties.

In contrast to the Ki„i Unit, the Punamanō Unit of the Refuge is naturally fed by rainfall, runoff, springs and groundwater seepage. Water flows from the marsh into Punamanō ditch and continues easterly. Currently, the unit consists of a north and south pond that are intermittently connected. The north pond has a water level of 2.5 feet above sea level. The temperature in the north pond is measured at 74.7°F, which is colder than ponds located further south. This suggests water may be coming from a separate, local source derived from the Ko„olau Mountains or it may be caused by evaporative cooling. The drainage area of the Punamanō Unit is 0.42 square miles (Hunt and De Carlo 2000).

**Figure 3-6. Hydrologic features of the Ki‘i Unit, James Campbell NWR.**




Source: Hunt and De Carlo (2000).

## 3.5 Topography/Bathymetry

The interior portions of O,,ahu gradually slope inward to a broad central valley. In contrast, the outer seaward slopes are tall and steep as a result of erosion from wind, rain and sea. Bathymetric mapping reveals that giant landslides and the associated slope failures are a significant component to the erosional history of the island. The coastal region of Kahuku is comprised of low coastal terraces less than 10 feet above sea level. The topography of the Refuge is nearly flat except for higher elevation dunes that lie seaward of the coastal terraces, inhibiting surface water flow to the ocean and causing ponding in the interior portions (Moore 1964, Polhemus 2007).

Lithified outcrops of eolianite along Kahuku Point and Makahoa Point create a sharp and jagged surface that makes access to the windward shoreline difficult. Extensive ridges of beach rock on the foreshore are found along the entire area. Along the windward coast, limestone outcrops and offshore islets can be found. Offshore fringing reefs are more extensive east of Kahuku Point due to the decreased wave energy compared to the northern coastline (Fletcher et al 2002).

## 3.6 Environmental Contaminants

The Agency for Toxic Substances and Disease Registry defines a contaminant as "a substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects." Contaminants commonly include pesticides and pesticide residues, industrial chemicals, fertilizers, metals, and other toxic substances. By altering biological or physical processes, contaminants may produce adverse effects to an ecosystem.

Contaminants are an important consideration of refuge management because wetlands depend on a constant supply of water for their maintenance. The quality of the habitat for the birds to be protected depends to a great extent on the quality of the water. Concern with the quality of surface and ground water has been the focus of extensive monitoring and study on O,,ahu for many years.

A Level II Contaminant Survey of sediments and tissues conducted in 1991 by the Service and a groundwater sampling conducted by the City of Honolulu in 1996 reported no contaminants at the Punamanō and Ki,,i units. However, a Ki,,i surface water sample by the University of Hawai,,i revealed high PCB concentrations. A followup Level 1 Preacquisition Contaminant Survey was subsequently performed in 1998 to characterize the PCB contamination. PCB detections were reported in 6 soil samples in a 20 by 50 feet area. This detection was due to a small, inadvertent spill of transformer oil that occurred in the late 1970s near the outlet channel. The PCB concentrations exceeded the ecological screening value of 0.023 ppm, suggesting further evaluation and potential remediation. At that time, the Service determined that it was safer to leave the PCBs in place than attempt to remove the contaminated soil. Follow-up monitoring is recommended to ensure the decision to leave the contamination in place has no negative impacts to endangered species in the Refuge (Harding ESE 2001).

Hunt and De Carlo (2000) conducted inorganic and organic chemical analysis by collecting water and sediment samples on the Refuge during a dry season (1994) and a wet season (1997). In 1994, water samples were collected from five sites and sediment samples from three sites in the Ki,,i Unit ponds. The 1997 survey consisted of water samples from the same five sites, as well as four additional water sample sites located on ditches and storm drains.

No significant water contamination by heavy metals or other potentially toxic trace elements was found during these studies. Elevated arsenic concentrations were detected between the dry season and wet season surveys, possibly due to fertilizer or pesticide runoff from upstream agricultural areas. In addition, a sample collected from Ki,,i Pond C during the 1994 survey had a copper concentration of 8.2 µg/L, which exceeds the aquatic life chronic criteria (6.5 µg/L) within the EPA ambient water-quality criteria. However, copper is naturally abundant in volcanic soils and consequently also occurs in higher concentrations in many sediments and waters. All other concentrations were comparable to heavy metal amounts found in nonimpact or low-impact areas throughout O,,ahu. Trace concentrations of several pesticides (including atrazine, simazine, chorpyrifos, diazinon, and trifluralin) were also detected in the water samples (Hunt and De Carlo 2000).

In the sediment samples, the organochlorine pesticide dichloro-diphenyl-trichloroethane (DDT) and its breakdown products dichloro-diphenyldichloro-ethylene (DDE) and dichloro-diphenyl-dichloroethane (DDD) were detected at or above the minimum reporting limit in surface samples of

bottom sediment from ponds C and D at the Ki„i Unit, as well as in a sediment core taken at Punamanō north pond. Concentrations were not at a level that posed any ecological risk. Trace concentrations of ametryn were detected at pond C at Ki„i and at Punamanō. Trace concentrations of bromacil, carboxin, diphenamid, and simetryn were detected in at the Punamanō core, and a trace of propachlor was detected at Ki„i pond D. The volatile organic compound toluene was detected at pond C (Hunt and De Carlo 2000).

The inorganic chemical survey results from the Ki„i and Punamanō Units were compared with available sediment-quality guidelines for freshwater sediments. In the Ki„i Unit, copper and zinc concentrations in sediments from ponds C and D exceeded the guidelines. Sediments from the north pond at the Punamanō Unit exceeded copper concentration limits. However, as these are naturally abundant in Hawaiian volcanic soils and are similar to concentrations found in other areas of O„ahu, the Service determined that no adverse biological effects would be associated with the contaminated sediment. As previously described, copper and also zinc are naturally abundant in Hawaiian volcanic soils and the detected concentrations were similar to concentrations found in other areas of O„ahu (Hunt and De Carlo 2000).

## 3.7 Land Use

This section presents an overview of land uses within and adjacent to James Campbell NWR that have the potential to influence Refuge conditions. Relevant local and regional land use policies affecting land use are also discussed.

The Administration Act identifies six priority wildlife-dependent visitor uses on refuges: hunting, fishing, wildlife observation and photography, and EE and interpretation. According to the Refuge Recreation Act of 1962, all recreational activities must be compatible with the primary purpose of the Refuge. Other laws or policies that may affect land use include: the Endangered Species Act of 1973; the Clean Water Act (CWA) or Federal Water Pollution and Control Act; the Migratory Bird Treaty Act of 1918; Executive Order 11988 (Floodplain Management); Executive Order 11990 (Protection of Wetlands), the Hawai„i Coastal Zone Management Act of 1977 (Hawai„i Revised Statutes, Chapter 205A); and the Master Plan for the Hawaiian Wetland NWR Complex (1983).

Under the State Land Use Law (Act 187), Hawai„i Revised Statute Chapter 205, all lands and waters in the State are classified into four districts: Agriculture, Rural, Conservation, and Urban. Conservation Districts are further divided into five subzones: Protective, Limited, Resource, General, and Special (Hawai„i Administration Rules, Title 13, Chapter 5). Land use is also dictated by zoning ordinances from the City and County of Honolulu.

The O„ahu General Plan is a comprehensive document with objectives and policies to address the physical, social, economic, and environmental concerns affecting the City and County of Honolulu. Island planning is further divided into eight regional areas that are guided by Development Plans or Sustainable Communities Plans (DPP 2006). The James Campbell NWR is located next to the community of Kahuku, within the Ko„olau Loa Sustainable Community Plan area.

### 3.7.1 Historic Land Divisions

The concept of private property was unknown to Native Hawaiians prior to Western contact, but they did follow a complex system of land division. All land was controlled ultimately by the highest ali,,i (chief or king) who held it in trust for the whole population. The ali,,i designated who supervised these lands based on their rank and standing. Each island was divided into several moku (units), usually wedge-shaped and running from the mountain crest to shore. O,,ahu was divided into six moku. Each moku was divided into smaller units known as ahupua,,a. Shaped by island geography, each ahupua,,a was a wedge-shaped area of land running from the uplands to the sea, following the natural boundaries of the watershed. The Refuge is located within the Kahuku ahupua,,a (Figure 3-5). Each ahupua,,a contained the resources the human community needed, from fish and salt, to fertile land for farming taro or sweet potato, to koa and other trees growing in upslope areas. Each ahupua,,a was ruled by an ali,,i and administered by a konohiki (headman or landlord) (Kamehameha 2011).

Stewardship of the land and its resources was formalized through the kapu system. The kapu, enforced by konohiki and kahuna (Hawaiian priest), placed restrictions on fishing certain species during specific seasons, on gathering and replacing certain plants, and on many aspects of social interaction as well. In this way, the community maintained a sustainable lifestyle (Kamehameha 2011).

The native landscape described in Land Commission testimonies (circa 1848) correlates with the verdant lush tropical landscape that was first witnessed by European explorers a half a century earlier. These conditions facilitated all phases of crop procurement for Native Hawaiians and provided rich marine resources, salt production capabilities, spring-fed marsh areas for taro, and suitable fish pond locations. Numerous testimonies attest to the rich hala groves within the general Kahuku plain. Coastal resources provided nearly all the necessary sustenance to establish coastal villages; while the adjacent steep hills, ridges, and lush upland regions of the Ko,,olau Range provided additional forested resources (Dougherty and Moniz-Nakamura 2005).

### 3.7.2 Ranching

The Mahele of 1848 changed land tenure in the Hawaiian Islands by defining land ownership and providing a legal course for land exchanges and purchases. A number of influential and powerful individuals were poised to secure large tracts of land through their close association with King Kamehameha III. These foreign investors were able to secure large tracts of lands awarded to either the king, konohiki, and to the government and people of Hawai,,i. Robert Moffitt, an Irish cattleman, secured large tracts of crown and konohiki lands along the northern point of O,,ahu and quickly transformed the landscape into pasturelands for ranching pursuits that included sheep flocks and cattle herds. The pasture lands extended along the coastal plain from the shoreline to the base of the Ko,,olau Range (Dougherty and Moniz-Nakamura 2005).

In 1850-51, only 3 years after the Mahele, Englishman Charles Gordon Hopkins purchased over 8,000 acres of Hawaiian lands, some from Moffitt and some in Mālaekahana from A. Keohakalole, and founded Kahuku Ranch, a cattle and sheep ranch. Other Englishmen who acquired large tracts of Kahuku lands at this time included R.C. Wyllie and H.A. Widemann. By 1873, Kahuku Ranch was owned solely by H.A. Widemann. In 1874, Kahuku Ranch was renamed Kahuku and Mālaekahana Ranch, and was sold to Julius L. Richardson, and in 1876, Richardson sold the ranch to James Campbell (Wilcox 1975).

## 3.7.3 Sugar, Pineapples, and Trains


*Kahuku Plantation Co. #1 c. 1946*
*Bishop Museum Collection*

A consortium of interests formed during the following decades. Development of islandwide transportation routes, ranches, land colonization, and sugar plantations coalesced, creating the conditions that facilitated rapid change within Kahuku. Benjamin Dillingham spearheaded efforts to construct rail lines to Kahuku to better facilitate the transport of raw sugar to the wharves in Honolulu. In 1890, James Campbell leased his Kahuku Ranch lands to Dillingham for 50 years, who then subleased these lands and the water rights to James Castle. The Kahuku Plantation Company, incorporated in 1890 through the partnership of James Castle and Alexander Young, planted 2,800 acres of cane and produced their first harvest in 1892. Irrigation for the crops was acquired through existing groundwater sources, streams, and pumped spring water; these sources eventually proved inadequate and artesian wells became the primary irrigation source. The crops were hauled to the Kahuku mill and from there were transported to the landing where the cane was shipped to Honolulu (Kuykendall 1967, Wilcox 1975).

The railway reached Kahuku in 1899, and provided O,,ahu residents with a passenger train service that remained in operation for 58 years. The Kahuku Plantation Co. began leasing land to individual pineapple growers during the mid-1900s. Similarly, the O,,ahu Railway & Land Co. leased land to individuals for pineapple cultivation. Ultimately, large areas of Kahuku were leased to the California Packing Corporation that later became the Del Monte Corp., who later subleased lands to the U.S. government for use as military training areas (Smith 1989).

*Private First Class Angelo Reina guards a lonely beach position at Kahuku © Rosenberg, March 1945*

Annexation of Hawai,,i to the United States and WorldWar II contributed to higher labor costs for plantation owners, and this combined with an expanding global sugar market reduced the plantation"s market competitiveness. The mill was officially shut down in 1971 (Wilcox 1975).

## 3.7.4 Military Use

Land developments of the area during World War II-era military modification included three emergency landing airstrips at the northern tip of O,,ahu (Kahuku Point Airfield, Kahuku Golf Course, and Kahuku Village), radio tower installations, barracks, and concrete bunkers.

The 18th Air base Group, 47th Pursuit Squadron, was stationed in Kahuku to protect the airfield and man shoreline fortifications. B-24s and B-17s were based at Kahuku for short periods of time during World War II. Most of the buildings and support structures associated with the Kahuku Air Field have been removed. A

portion of the old runway, a few scattered concrete pillboxes, and antenna supports covered by low brush and debris can be found in the coastal shrubland (McKillop 2005).

The Kahuku Training Area is situated south of the Refuge on the slopes of the Koʻolau Mountain Range. It remains an active training area available for military units in Hawai,,i to maintain their combat readiness.

### 3.7.5 Land Use Today

Modern-era activities generating further land modifications include diversified agricultural pursuits and extensive aquaculture farm facility construction. These pursuits are situated on previously cultivated cane lands and constitute expansive modifications. Hotel and golf course developments located on the coastal plain represent considerable land modifications of relatively large, contiguous areas. These large development activities combined with relatively smaller project developments have produced widescale land changes on the Kahuku Plain. The Refuge is bordered by Kamehameha Highway to the south and the Pacific Ocean to the north. Adjacent land uses to the south include First Wind windfarm, Kahuku Wastewater Treatment Plant, Kahuku Golf Course, the abandoned Kahuku sugar mill, Kahuku Hospital, Kahuku High School, and the northern section of the Mālaekahana State Recreation Area. Land uses to the northwest include kuleana lands, Links Golf Course, and the Turtle Bay Resort. Turtle Bay Resort is a 26-acre hotel and commercial development north of the Refuge. Potential future uses of lands adjacent to the Refuge include agriculture, aquaculture, golf courses, parks, conservation areas, or residential development.

During the sugar cane era, the Ki,,i area was used as settling ponds to wash sugar cane at the Kahuku Sugar Mill. When the mill closed in 1971, the ponds dried and were no longer used by waterbirds. The Service entered into a long-term lease agreement with the landowner, the Estate of James Campbell, to increase waterbird habitat. Restoration at the Ki,,i Unit began in 1977. In addition to agricultural uses, Punamanō Pond was once used as a fishpond by local residents.

On May 25, 2006, the James Campbell National Wildlife Refuge Expansion Act of 2005 (the Act), Public Law 109-225, expanded the existing Refuge boundary by approximately 750 acres, creating a total of 1,100 acres of protected wildlife habitat. The new area, which includes coastal lowland wetlands, dunes, and strand habitat makai (seaward) of Kamehameha Highway in the Kahuku coastal plain, linked the original Refuge units to the ocean shore. The Act was enacted by Congress and the President due to longstanding public concerns for protecting Oʻahuʻs natural resources and open space on the Kahuku coastal plain.

*Romy's Kahuku Prawns & Shrimp*
*Laura Beauregard/USFWS*

There are two commercial lessees on the Refuge, Romyʻs and Ming Dynasty, that raise freshwater shrimp and prawns in aquaculture ponds next to Kamehameha Highway. They are located on a parcel of land acquired by the Refuge in December 2009.

Under an agreement with the James Campbell Company, these leases were transferred to the Service and will expire in 2023.

## 3.8 Refuge Facilities

Equipment storage and maintenance operations for all of the O,,ahu National Wildlife Refuge Complex are based out of the Ki,,i Unit of the James Campbell NWR. The base yard is located near the current public entrance off Kamehameha Highway within a fence along the southwest perimeter of the Ki,,i Unit. The area encompassed by the facility is approximately one acre and consists of a maintenance equipment storage and office facility within a metal building (constructed in 2003). There is a three-sided roofed area for additional storage and four portable secured storage containers used to safeguard tools and other management-related equipment and materials. Two kiosks and interpretative signs demark a short nature walk.

# Chapter 4. Refuge Biology and Habitat

This chapter addresses the biological environment of James Campbell NWR; however, it is not an exhaustive overview of all species occurring within the Refuge. The chapter begins with a discussion of biological integrity; we then focus on the presentation of pertinent background information for the conservation targets designated under the CCP. Background information includes a description, location, condition, and the trends associated with wildlife or habitats, key ecological attributes, and stresses and sources of stress (collectively, "threats") to the target. The information presented was used when the CCP team developed goals and objectives for each of the conservation targets.

## 4.1 Biological Integrity Analysis

The Administration Act directs the Service to ensure that the biological integrity, diversity, and environmental health (BIDEH) of the Refuge System are maintained for the benefit of present and future generations of Americans. The Service‟s policy on BIDEH (601 FW 3) also provides guidance on consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on refuges, and associated ecosystems that represent BIDEH on each refuge.

Biological integrity lies along a continuum from a completely natural system to a biological system extensively altered by considerable human impacts to the landscape. No modern landscape retains complete biological integrity, diversity, and environmental health. However, we strive to prevent the further loss of natural biological features and processes. Maintaining or restoring biological integrity is not the same as maximizing biological diversity. Maintaining biological integrity may entail managing for a single species or community at some refuges and combinations of species or communities at other refuges. Maintaining critical habitat for a specific endangered species, even though it may reduce biological diversity at the refuge scale, helps maintain biological integrity and diversity at the ecosystem or national landscape scale.

On refuges, we typically focus our evaluations of biological diversity at the refuge scale; however, these refuge evaluations can contribute to assessments at larger landscape scales. We strive to maintain populations of breeding individuals that are genetically viable and functional. Evaluations of biological diversity begin with population surveys and studies of flora and fauna. The Refuge System‟s focus is on native species and natural communities such as those found under historical conditions.

We evaluate environmental health by examining the extent to which environmental composition, structure, and function have been altered from historic conditions. Environmental composition refers to abiotic components such as air, water, and soils, all of which are generally interwoven with biotic components (e.g., decomposers live in soils). Environmental structure refers to the organization of abiotic components, such as atmospheric layering, aquifer structure, and topography. Environmental function refers to the processes undergone by abiotic components, such as wind, tidal regimes, evaporation, and erosion. A diversity of abiotic composition, structure, and function tends to support a diversity of biological composition, structure, and function.

We strive to manage in a holistic manner the combination of BIDEH. We balance all three by considering refuge purpose(s), Refuge System mission, and landscape scales. Where practical, we

support the return of extirpated native species in the context of surrounding landscapes. The BIDEH for James Campbell NWR is characterized in Table 4-1, below.

**Table 4-1. Biological Integrity, Diversity, and Environmental Health Characteristics**

| Habitats | Population/Habitat Attributes | Natural processes responsible for these conditions | Limiting Factors |
|---|---|---|---|
| Emergent wetland | Seasonal, semi-permanent, permanent<br><br>Potential conservation species: endangered waterbirds, migratory waterfowl, and shorebirds | Natural springs; surface runoff; periodic flooding; seasonal fluctuations/drying, but more permanent water situations than typical seasonal wetlands | Diked impoundments, human development, disrupted flow patterns, and pest species including California grass, California bulrush, marsh fleabane, *Batis*, water hyssop, and mangrove |
| Dry coastal shrub/scrub community | Mixed shrub and grassland<br><br>Potential conservation species: endangered waterbirds, shorebirds, and seabirds | Exposed coral shelf due to ancient sea level subsidence, low annual precipitation, subsurface sea water (tidal) influence | Invasive species: kiawe, marsh fleabane, buffel grass, *Verbesina*, and koa haole |
| Coastal dunes | Beach strand/dune communities<br><br>Potential conservation species: seabirds, shorebirds, endangered ‚ilio-holo-i- ka-uaua, threatened honu | Onshore winds, salt spray, sandy soil, wave and tidal action | Pest species: tree heliotrope, silverhead, spiny amaranth, mongooses, rats, cats, dogs, and pigs; livestock grazing; human development and disturbance; and marine debris |
| Exposed coral shelf and anchialine pools | Coastal areas; shallow, poorly developed soil with a coral base; eroded vertical sinkholes occur<br><br>Potential conservation species: *Metabeteaus lohena*, pinapinao | Sea level subsidence, subterranean sea water influence, dry conditions, low amounts of surface organic matter | Pest species: kiawe, marsh fleabane, Chinese violet, buffel grass, and koa haole |

## 4.2 Conservation Targets

Conservation targets are those species or habitats that are most important to the management of the Refuge. Management for these focal species and habitats that support them will benefit other native species that are present on the Refuge. Table 4-2 identifies the priority resources of concern for James Campbell NWR. As native species are referenced by their Hawaiian names, Appendix A contains a list of all scientific, English, and Hawaiian names.

*Nesting ʻalae ʻula Mike Silbernagle/USFWS*

**Table 4-2. Priority Resources of Concern.**

| Focal Species | Habitat Type | Habitat Structure | Life-history Requirements | Other Benefiting Species |
|---|---|---|---|---|
| **ʻAlae keʻokeʻo** | Flooded wetlands | Open water (< 18 in. depth) | Foraging, loafing | Migratory waterfowl, shorebirds, ,,alae ,,ula, and koloa maoli |
| | Emergent wetland | Hemi-marsh with kaluhā sedge | Nesting, brood rearing | |
| | Mudflats | Moist-saturated soil | Foraging, loafing | |
| | Levees | Ground cover vegetation | Foraging, loafing | |
| **ʻAlae ʻula** | Flooded wetlands | Open water (< 18 in. depth) | Foraging, loafing | Migratory waterfowl, shorebirds, ,,alae ke,,oke,,o, and koloa maoli |
| | Emergent wetland | Hemi- to permanent marsh with sedge, cattail, and bulrush | Nesting, brood rearing | |
| | Mudflats | Moist to saturated soil | Foraging, brood rearing, loafing | |
| | Levees | Ground cover vegetation | Foraging, loafing | |
| **Aeʻo** | Flooded wetland | Shallow water (< 7 in. depth) | Foraging, loafing | Migratory waterfowl, shorebirds, ,,alae ,,ula, ,,alae ke,,oke,,o, and koloa maoli |
| | Mudflats | Adjacent vegetation (cover) and shallow water | Nesting, brood rearing | |

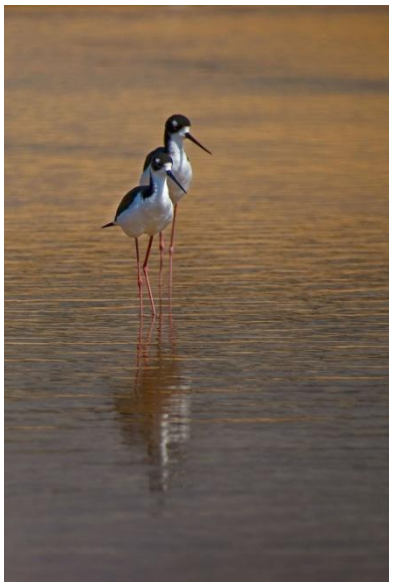
| Focal Species | Habitat Type | Habitat Structure | Life-history Requirements | Other Benefiting Species |
|---|---|---|---|---|
| **Koloa maoli** | Low disturbance flooded/ emergent wetlands | Open water < 8 in. depth supporting seed-bearing plants and invertebrates for food | Foraging, loafing, and chick rearing yearlong | Migratory waterfowl, shorebirds, ,,alae ,,ula, ae,,o, and ,,alae ke,,oke,,o |
| | Low disturbance grassy upland adjacent to/in wetlands | Dry land with vegetative concealment cover | Nesting, yearlong major period March-June | Migratory waterfowl, shorebirds |
| **‘Īlio-holo-i-ka-uaua** | Beach areas; sand spits and islets, including all beach crest vegetation; lagoon waters; inner reef waters; and open ocean | Sandy shoreline, rocky areas, and emergent reefs; as well as vegetated areas for shelter | Pupping, nursing, resting, and molting | Honu, shorebirds, and seabirds |
| **Honu** | Shallow, protected water with abundant aquatic vegetation; coral reefs; beach areas; sand spits and islets; and open ocean | Open beaches with a sloping platform and minimal disturbance are required for nesting | Basking and nesting | ,,Īlio-holo-i- ka-uaua, shorebirds, and seabirds |

# 4.3 Endangered Hawaiian Waterbirds

James Campbell NWR was established to provide protected managed habitat for four of Hawai„ï's endangered waterbirds. According to the Draft Revised Recovery Plan for Hawaiian Waterbirds, the Refuge is designated as a core wetland, which is an area essential to the recovery and delisting of all four waterbird species. This Refuge is one of the five core wetland complexes located on O„ahu that are continually managed for endangered waterbirds (USFWS 2005).

The primary causes of Statewide population decline for these four endangered waterbirds include loss of wetland habitat, predation by introduced animals, altered hydrology, habitat alteration by pest plants, and disease. Environmental contaminants may threaten populations in certain areas. The general recovery objectives are: stabilize or increase species population to greater than 2,000 individuals; establish multiple self-sustaining breeding populations throughout their historic ranges; protect and manage core and supporting wetlands Statewide; eliminate or control the threat of introduced predators, diseases, and contaminants; and remove the threat of koloa maoli hybridizing with non-migratory mallards.

## 4.3.1 Ae‘o (*Himantopus mexicanus knudseni*) or Hawaiian Stilt



*Ae‘o pair © Brian Barker*

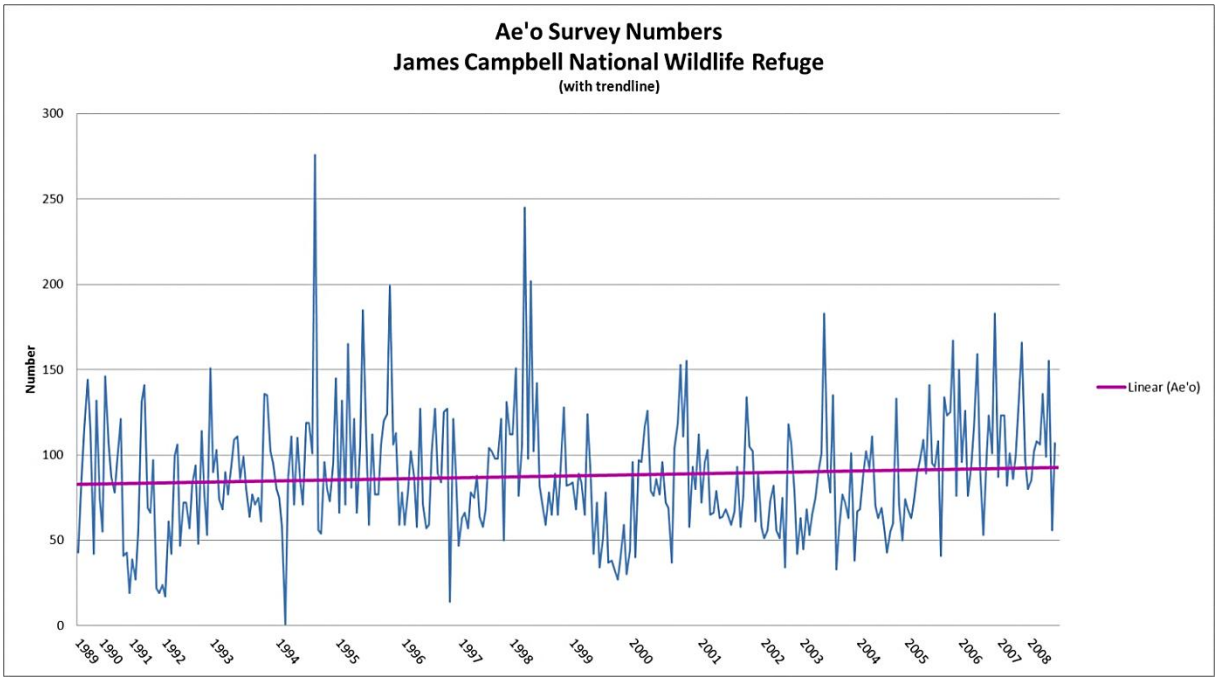
The ae„o is an endemic subspecies in the Hawaiian Islands, which is part of a superspecies complex of stilts found in various parts of the world. The U.S. Pacific Islands Regional Shorebird Conservation Plan considers the ae„o as highly imperiled because of its low population level. The ae„o population has shown a general upward trend Statewide over the past 25 years, although annual summer and winter counts have shown variability from year to year. This fluctuation can be attributed to winter rainfall and successful reproduction. The State population of this resident non-migratory shorebird fluctuates between 1,200-1,500 birds with a 5-year average of 1,350 birds. Adult and juvenile dispersal has been observed both intra- and inter-island (Robinson et al. 1999).

Ae„o numbers fluctuate seasonally with the overall population trend on the Refuge showing a general decline during the summer months and a general increase during the winter months over the past 30 years. Annual numbers vary with habitat availability for this species. Peak numbers range as high as 276 birds. Ae„o survey numbers are shown in Figure 4-1. With the addition of new Refuge acreage, increased year-round habitat for ae„o will become available and will have a positive effect on their numbers.

Ae„o favor open wetland habitats with minimal vegetative cover and water depths less than 9.4 inches, as well as tidal mudflats. Ae„o nest from mid-February to late August. Nesting sites consist of simple scrapes on low relief islands or undulating wetland bottom topography within and/or adjacent to ponds. Ae„o tend to be opportunistic users of ephemeral wetlands to exploit seasonal abundance of food, feeding on small fish, crabs, polychaete worms, terrestrial and aquatic insects, and tadpoles (Robinson et al. 1999, Rauzon and Drigot 2002).

Although ae,,o are considered imperiled, it is believed to have high recovery potential with a moderate degree of threat. Barn owls and pueo (Hawaiian short-eared owl) are known predators of adult ae,,o. Known predators of eggs, nestlings, and young include mongooses, cats, rats, dogs, ,,auku,,u (black-crowned night-heron), cattle egrets, common mynas, ,,akekeke (ruddy turnstone), laughing gulls, American bullfrogs, and large fish. Ongoing threats to foraging and breeding birds on Refuge lands include predation by introduced vertebrates; pest plants; disease; and potential environmental contaminants.

**Figure 4-1**



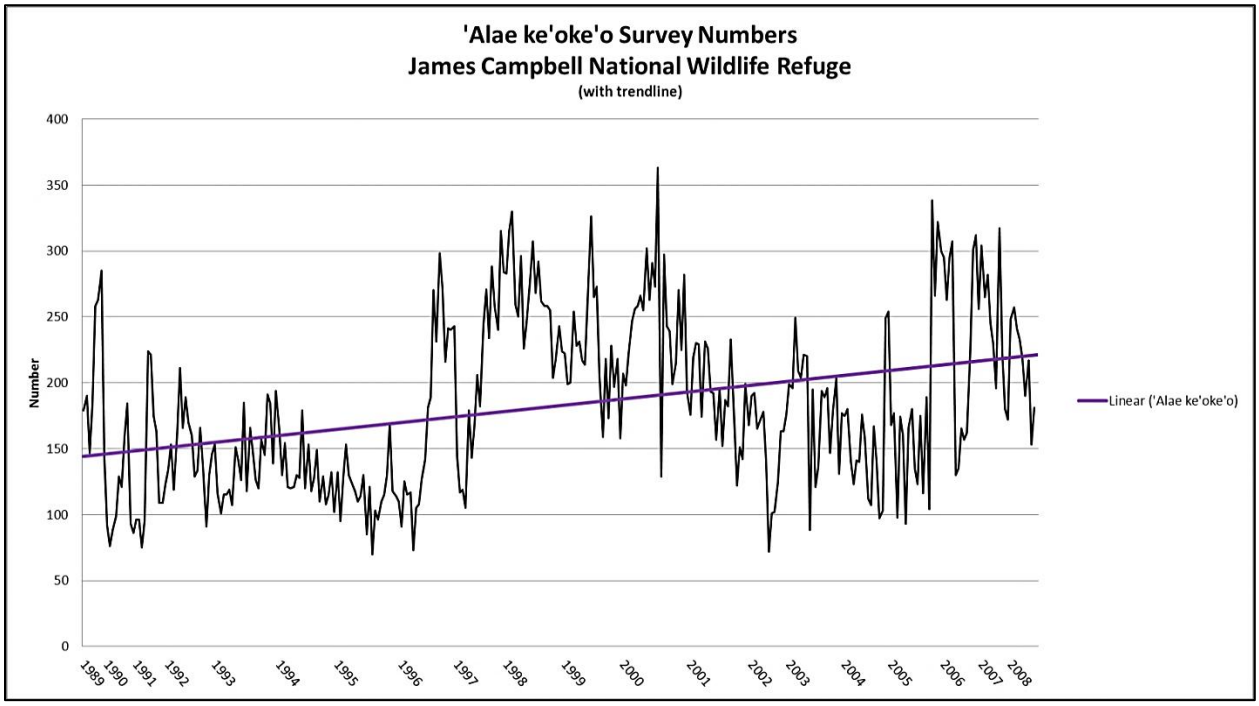

## 4.3.2 ‘Alae ke‘oke‘o (*Fulica alai*) or Hawaiian Coot

The ,,alae ke,,oke,,ois an endangered species endemic to the main Hawaiian Islands, except Kaho,,olawe, and has occurred sporadically as a vagrant to the NWHI, as far west as Kure Atoll. The Draft Revised Recovery Plan for Hawaiian Waterbirds lists the ,,alae ke,,oke,,o as having high potential for recovery and a low degree of threats. The North American Waterbird Conservation Plan considers the ,,alae ke,,oke,,oas a species of high concern. The State population has fluctuated between 2,000-4,000 birds with the O,,ahu population fluctuating between 500-1,000 birds. Interisland dispersal is most likely influenced by seasonal rainfall patterns, wetland condition and food abundance (Brisbin et al 2002).

*‘Alae ke‘oke‘o Laura Beauregard/USFWS*

„Alae ke„oke„o numbers on the Refuge fluctuate seasonally with the overall population trend on the Refuge showing a moderate increase over the past 30 years. Improved predator controls as well as habitat and water level management that provides more suitable habitat for this species throughout most of the year on the Refuge have contributed to the increase. The high count for „alae ke„oke„oon the Refuge was 358 birds, survey numbers are shown below in Figure 4-2. With the addition of new Refuge acreage, increased year-round habitat for „alae ke„oke„o will become available and will have a positive effect on their numbers.

**Figure 4-2**




„Alae ke„oke„o are usually found on island coastal plains and prefer freshwater ponds or wetlands, brackish wetlands, and manmade impoundments. They prefer open water that is less than 12 inches deep for foraging and nesting habitat that has openwater with emergent aquatic vegetation or heavy stands of grass. Nesting occurs mostly March-September, with opportunistic nesting occurring year round depending on rainfall. „Alae ke„oke„o will construct floating nests of aquatic vegetation, semi-floating nests attached to emergent vegetation, or in clumps of wetland vegetation. False nests are also sometimes constructed and used for loafing or brooding platforms. „Alae ke„oke„o feed on seeds and leaves of aquatic and terrestrial plants, freshwater snails, crustaceans, tadpoles of marine toads, small fish, and aquatic and terrestrial insects (Schwartz and Schwartz 1949, Brisbin et al. 2002).

Cats, dogs, and mongooses are the main predators of adult and young „alae ke„oke„o Other predators include the „auku„u, cattle egret, and large fish. „Alae ke„oke„oare susceptible to avian botulism outbreaks in the Hawaiian Islands (Brisbin et al. 2002).

## 4.3.3 ʻAlae ʻula (*Gallinula chloropus sandvicensis*) or Hawaiian Moorhen

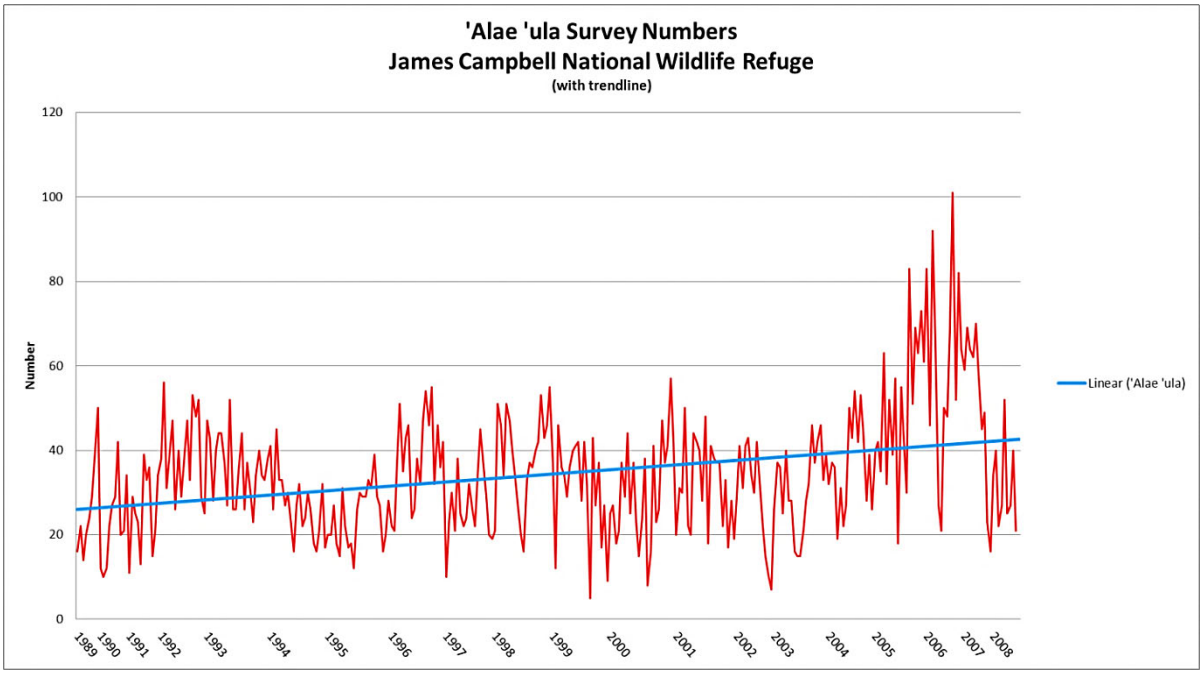
The ʻalae ʻula is an endemic, non-migratory subspecies of the common moorhen (*Gallinula chloropus*). It is believed the subspecies originated from stray migrants from North America that colonized Hawaiʻi. Although it previously occurred on all the main Hawaiian Islands except Lanaʻi and Kahoʻolawe, this species is currently only found on the islands of Kauaʻi and Oʻahu. The ʻalae ʻula is considered to have a high potential for recovery with a moderate degree of threats (Hawaiʻi Audubon Society 2005, Kushlan et al. 2002).

*ʻAlae ʻula Mike Silbernagle/USFWS*

Cats, dogs, mongooses, and bullfrogs are known predators with ʻauku and rats as possible predators. The ʻalae ʻula is highly susceptible to human and predator disturbance. ʻAlae ʻula are very secretive; thus, population estimates and long-term population trends are difficult to approximate. The Statewide population appears to be stable, with an average annual total of 314 birds between 1977 and 2002. Approximately half of this population occurs on Oʻahu (Engilis and Pratt 1993, Bannor and Kiviat 2002, Hawaiʻi Audubon Society 2005).

ʻAlae ʻula numbers on the Refuge fluctuate seasonally with the overall population trend on the Refuge showing a general increase over the past 30 years. Annual numbers vary with habitat availability for this species, with a high count of 98 birds, as shown below in Figure 4-3. With the addition of new Refuge acreage, increased year-round habitat for ʻalae ʻula will become available and will have a positive effect on their numbers.

**Figure 4-3**



## 4.3.4 Koloa maoli (*Anas wyvilliana*) or Hawaiian Duck

*Koloa-mallard hybrids Mike Silbernagle/USFWS*

The koloa maoli is an endangered waterfowl endemic to the Hawaiian Islands. The former range of the koloa includes all the main Hawaiian Islands except Lana,,i and Kaho,,olawe. Currently, the only naturally occurring population of koloa maoli exists on Kaua,,i with repatriated populations on O,,ahu, Hawai,,i, and Maui. The Draft Revised Recovery Plan for Hawaiian Waterbirds lists the koloa maoli as having a high potential for recovery and a high degree of threat due to hybridization with mallard ducks, the greatest threat to this species" continued existence. The current Statewide population of pure koloa is estimated at 2,200 birds; approximately 2,000 individuals occur on Kaua,,i and the remainder reside on the Island of Hawai,,i. Birds on O,,ahu and Maui are thought to be primarily koloa-mallard hybrids, with estimated counts of 300 and 50 birds, respectively. Although hybridization is still a threat on the islands of Kaua,,i and Hawai,,i, the koloa maoli population on these two islands appear to be stable. Three pure koloa maoli were found at James Campbell NWR during a genetic testing survey in 2008 (USFWS 2005, Engilis et al. 2002, Hawaii Audubon Society 2005, Uyehara et al. 2007).

The koloa maoli uses natural and manmade lowland wetlands, flooded grasslands, river valleys, mountain streams, montane pools, forest swamplands, aquaculture ponds, and agricultural areas. The Refuge provides suitable habitat for foraging, loafing, pair formation, and breeding. The majority of nesting occurs from March-June with broods observed year-round. Nests are placed in dense shoreline vegetation of small ponds, streams, ditches, and reservoirs. Types of vegetation associated with the nesting sites of koloa maoli include fetched and bunch-type grasses, rhizominous ferns, and shrubs. The diet consists of aquatic invertebrates, aquatic plants, seeds, grains, green algae, aquatic mollusks, crustaceans, and tadpoles (Engilis et al. 2002, USFWS 2005a).

In addition to hybridization concerns, other hazards exist for koloa maoli. Known predators of eggs and ducklings include mongooses, cattle egrets, cats, dogs; and possibly rats and Samoan crabs. „Auku,,uand bullfrogs have been observed to take ducklings. Avian diseases are another threat to koloa maoli with outbreaks of avian botulism occurring annually throughout the State. In 1983, cases of adult and duckling mortality on O,,ahu were attributed to aspergillosis and salmonella. In order for pure koloa maoli to successfully breed on O,,ahu, the removal of all hybrids and mallard ducks will need to occur (Engilis et al. 2002).

# 4.4 Other Hawaiian Waterbirds

## 4.4.1 ʻAukuʻu (*Nycticorax nycticorax hoactli*) or Black-crowned Night-heron

*ʻAukuʻu looks for prey Laura Beauregard/USFWS*

The indigenous ʻauku,u is a cosmopolitan species resident to the main Hawaiian Islands. The black-crowned night-heron is a species of moderate concern in North America; however, ʻauku,u in Hawai,i are not given this designation. In the past, this species has used the Refuge only for foraging. The high count for ʻauku,u was 109 birds in the Ki,i and Punamanō Units. There are breeding colonies within the new acquisition lands and we expect to maintain the current population size, which will result in higher numbers for the Refuge.

ʻAuku,u usea wide range of aquatic habitat types including mountain streams, lowland ponds and estuaries, aquaculture farms, and suburban/urban waterways. The ʻauku,u is diurnal in Hawai,i and is known to forage on crustaceans, insects, fish, frogs, and mice. They have been observed eating the eggs and young of the endangered ae,o, koloa maoli, and ʻalae keʻoke,o. This species may also be a predator of ʻalae ʻula eggs and young. Nesting occurs in colonies in December-February in Hawai,i. ʻAuku,u are susceptible to human disturbance during nesting (Davis 1993, Mitchell et al. 2005, USFWS 2005a).

# 4.5 Migratory Waterfowl

*Koloa mohā © Michael Walther*

For centuries, migratory ducks, geese, and other waterfowl have wintered on the Hawaiian Islands from September to May. Of the nearly 30 species of migratory ducks and geese using the islands, the most common winter migrants observed at James Campbell NWR include koloa mohā (northern shoveler), koloa māpu (northern pintail), mallard, lesser scaup, green-winged teal, and American wigeon. Migratory mallards do not pose the same hybridization threats to koloa maoli as the domestic, resident mallards because they rarely breed during their winter stop-overs (Staples & Cowie 2001).

## 4.6 Migratory Shorebirds

*An ‘akekeke forages during visit © Michael Walther*

The Pacific Island Region functions as essential migratory habitat for maintaining global shorebird populations. James Campbell NWR plays an important role in providing wintering grounds for shorebirds in the Hawaiian Islands. Thirty-five species of shorebirds have been recorded on the Refuge. The most common migratory shorebirds by order of abundance on O„ahu wetland refuges are the kōlea (Pacific golden-plovers), „akekeke, hunakai (sanderling), and „ūlili (wandering tattler) (Table 4-3). The only resident shorebird is the ae„o.

The majority of the migratory shorebirds use the Refuge from August to April for loafing and foraging (Engilis and Naughton 2004).

Shorebirds primarily utilize wetlands and tidal flats; however, estuaries, grasslands, and uplands are also important habitats. Although large portions have been altered for urban development, O„ahu offers the most diverse shorebird habitat of all the Hawaiian Islands. Grasslands and beaches are important habitats for the kōlea and the kioea (bristle-thighed curlew). O„ahu golf courses support an estimated 1,900 kōlea during the winter, and this species has even been observed roosting on urban rooftops (Engilis and Naughton 2004).

Threats to shorebirds in the Pacific Region include habitat loss, pest plants and animals (predation, disease, and competition), human disturbance, and environmental contaminants. The kōlea is the most common shorebird in the Pacific Region, with Hawai„i supporting a substantial portion of the Alaskan breeding population during winter. The kioea is the only migratory species that exclusively winters in the Pacific. Thus, the Pacific Region is considered to be a critical area for supporting hemispheric populations of both these species (Engilis and Naughton 2004).

**Table 4-3. Shorebirds of Primary Conservation Importance in the Pacific Region**

| Species | Hawai‘i Winter Population | Regional Trend | Conservation Category |
|---|---|---|---|
| Kōlea | 15,000-20,000 | Unknown | High Concern |
| Ae„o | 1,200-1,600 | Unknown | Highly Imperiled |
| Kioea | 800 | Unknown | High Concern |
| „Ūlili | 1,000 | Unknown | Moderate Concern |
| „Akekeke | 5,000-7,000 | Unknown | Low Concern |

Source: Engilis and Naughton (2004)

# 4.7 Seabirds

*Resting ʻuaʻu kani © Michael Walther*

The ,,ua,,u kani is the only seabird currently known to nest on the Refuge. Reproductive success is unknown but predation appears to be a major limiting factor. Six seabird species have been selected for priority management because of their habitat preferences at other nesting sites in Hawai,,i that resemble the conditions at the Refuge. In order of feasibility of attraction and colony establishment, the species are mōlī, ,,ua,,u kani, koa,,e,,ula, ,,a, ka,,upu, and Christmas shearwater. These species are currently observed along the Refuge coastline and vicinity. Mōlī have attempted to nest near the Refuge but were killed by dogs.

# 4.8 Raptors

## 4.8.1 Pueo (*Asio flammeus sandwichensis*) or Hawaiian Short-eared Owl

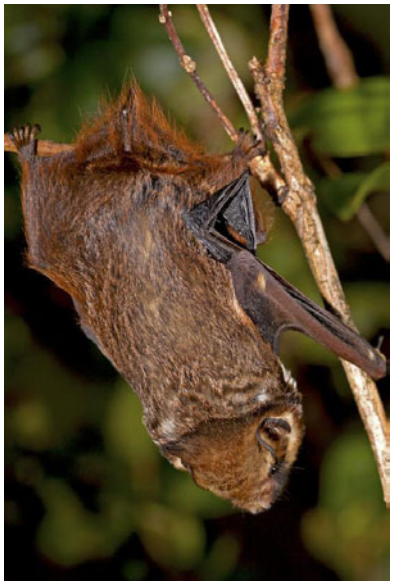
Pueo are hard to detect and we do not have accurate counts for their presence. No nests have been documented to date. The Refuge offers breeding and foraging habitat for the pueo. Unlike most owls, pueo are diurnal and are occasionally seen hovering or soaring over open areas. Like short-eared owls in continental environments, those in Hawai,,i primarily consume small rodents, insects, and rarely, birds. Males perform aerial displays known as a sky dancing display to prospective females.

Found on all the main Hawaiian Islands from 0-8,000 feet, pueo occupy a variety of habitats including wet and dry forests. Listed by the State as Endangered on O,,ahu, pueo are likely susceptible to the same factors that threaten other native Hawaiian birds, including loss and degradation of habitat, predation by introduced mammals, and disease.

*Pueo © Tom Dove*

# 4.9 Endangered Mammals

## 4.9.1 ʻŌpeʻapeʻa (*Lasiurus cinereus semotus*) or Hawaiian Hoary Bat



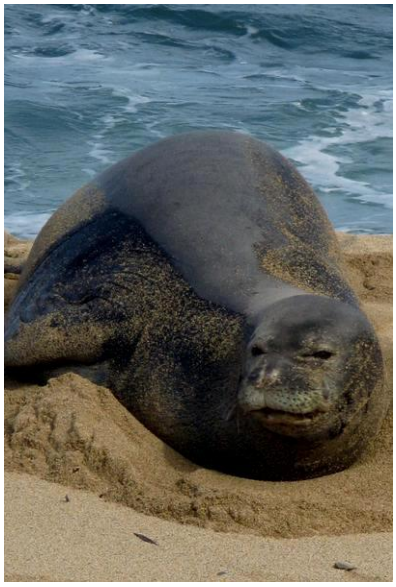
*ʻŌpeʻapeʻa Dan Clark/USFWS*

The ʻōpeʻapeʻa is Hawaiʻi's only native terrestrial mammal, although fossil evidence indicates that at least one other bat species was native to the islands. Males and females have a wingspan of about 1 foot, and females are typically larger than males. Both sexes have a coat of brown and gray fur. Individual hairs are tipped or frosted with white; "hoary" means frosted. The Hawaiian name refers to a half taro leaf or canoe sail shape; these being somewhat similar to the shape of the bat.

We suspect ʻōpeʻapeʻa may use the Refuge for foraging areas, just before and after sunset, feeding on a variety of night-flying insects, including moths, beetles, crickets, mosquitoes, and termites. They have been documented near the Refuge. Water courses and edges (e.g., coastlines and forest/pasture boundaries) appear to be important foraging areas; the species also is attracted to insects that congregate near lights. Breeding has only been documented on the islands of Hawaiʻi and Kauaʻi. Bats are affected by habitat loss, pesticides, predation, and roost disturbance. A reduction in tree cover (e.g., roost sites) might be the primary reason for the species' decline in Hawaiʻi.

## 4.9.2 ʻĪlio-holo-i-ka-uaua (*Monachus schauinslandi*) or Hawaiian Monk Seal

ʻĪlio-holo-i-ka-uaua are among the most critically endangered mammals in the world. Only about 1,200 seals are alive today. Most seals live in the NWHI, but there is a small and potentially growing population of seals in the main Hawaiian Islands where a 2005 survey observed 76 individuals.



*ʻĪlio-holo-i-ka-uaua rests on beach*
*© Jim Collin/ AP*

Its Hawaiian name means "the dog that runs in the rough seas." They frequently haul-out on shorelines to rest and molt. Females also haul-out on shore for up to 7 weeks to give birth and nurse their pups. Pups and moms stay ashore until weaned. Mating occurs in the spring and early summer. Gestation is approximately 1 year. Pupping occurs in late winter and spring. ʻĪlio-holo-i-ka-uaua can live to 25 years of age.

They feed on reef fishes, heʻe (octopus), squid, and lobsters down to depths of 1,000 feet. Juveniles feed on a higher proportion of nocturnal fish species. Food seems to be a limiting factor for population growth at this time. Īlio-holo-i-ka-uaua are usually solitary except when on preferred beaches when they may be close together and interact.

Populations have been decreasing recently in the NWHI, possibly due to sea level rising above some islands. Terrestrial habitat is used about one-third of the time and requirements there include haul-out areas for pupping, nursing, and resting, primarily on sandy beaches, but virtually all substrates are used. Beachside vegetation is used for protection from wind and rain.

Conflicts and interactions with a variety of ocean and beach users are becoming more frequent and significant in the main Hawaiian Islands. Dogs have attacked ʻīlio-holo-i-ka-uaua, and they carry diseases that are potentially lethal to ʻīlio-holo-i-ka-uaua. Human disturbance, especially of mothers with pups, may be a threat at the Refuge. Prior to recent acquisition, Refuge lands did not include the shoreline habitat suitable for this species, therefore monitoring did not occur. Incidental observations over the past year have documented at least two individuals hauling-out on the shore on several occasions. Increased monitoring will provide a better understanding of the use; and management is expected to increase the likelihood of pupping along the Refuge shoreline. In recent years, pupping has been documented nearby on the shore between the Turtle Bay Resort and the Refuge.

# 4.10 Invertebrates

## 4.10.1 ʻŌpaeʻula (*Halocaridina rubra)* or Hawaiian Red Shrimp

The ʻōpaeʻula is a tiny (less than half an inch long) reddish shrimp of the family Atyidae found only in Hawaiʻi's brackish water anchialine pools. It is the most common species of anchialine shrimp in Hawaiʻi and can reach 15 years of age, an unusually long time for a tiny crustacean. This species is known to occur on the islands of Hawaiʻi, Maui, and Oʻahu. They graze on the film of algae and diatoms growing on rocks and other hard surfaces. This endemic species is threatened by loss of habitat due to coastal development, the introduction of predatory pest fishes, and perhaps by collection for the pet trade. Its Hawaiian name means "red shrimp." Eight different genetic lineages of ʻōpae ʻula exist in Hawaiʻi. Data show that a lineage was confined to a particular region of a single Hawaiian Island, with each island harboring at least two lineages.

ʻŌpaeʻula are known to occur in two locations on the Refuge. Due to some of the geologic features found in the expansion area, additional anchialine pools containing this species are anticipated. If degraded sites are found, habitat restoration will be pursued.

# 4.11 Marine Reptiles

## 4.11.1 Honu (*Chelonia mydas*) or Hawaiian Green Turtle

Honu use the Refuge beach for resting and nesting. Mature males are distinguished from females by their longer, thicker tails. Little information exists on the feeding behavior of post-hatchlings and juveniles living in pelagic habitats, but most likely they are exclusively carnivorous (e.g., soft-bodied invertebrates, jellyfish, and fish eggs). Subadult and adult turtles residing in nearshore benthic environments are almost completely herbivorous;

*Honu basking on the shore Laura Beauregard/USFWS*

feeding primarily on select macroalgae and sea grasses. The common name “green sea turtle” is derived from the color of their body fat, which is green from the limu (algae) they eat. Adult honu can weigh up to 500 pounds and are often found living near coral reefs and rocky shorelines where limu is plentiful. Hawaiian honu display slow growth rates, even compared to other populations, with an average annual growth rate of approximately ½-2 inches per year. Turtles often reach sexual maturity at 35-40 years of age (Gardner 1996).

Females may lay up to 6 clutches per season, often returning to the same site for each clutch every 12-15 days. Each clutch contains approximately100 eggs and sex determination is temperature-dependent. Incubation takes about 60 days. Evidence shows that Hawaiian honu only migrate throughout the 1,500-mile expanse of the Hawaiian Archipelago, and so make up a discrete population. Hatchlings and juveniles live in pelagic waters, but little is known of their specific distribution.

Litter and other marine debris can prove deadly when they entangle honu or are mistaken for food and ingested. Plastics are particularly harmful as they may remain in the honu's stomach for long periods of time, releasing toxic substances. Ingested plastics also can clog the digestive system. Noise, lights, and beach obstructions are disruptive to nesting areas and rats, mongooses, and dogs prey on the eggs. The Hawaiian honu is listed as threatened under the ESA (Perrine 2003).

Conflicts and interactions with a variety of ocean and beach users are becoming more frequent and significant in the main Hawaiian Islands. Human disturbance to adults coming to shore to lay eggs may be a threat at the Refuge. Prior to recent acquisition, Refuge lands did not include the shoreline habitat suitable for this species, therefore monitoring by Refuge personnel did not occur. Some information gathered by NOAA indicates historic use of the area. A first attempt at annual monitoring occurred in 2010, resulting in at least one successful nest with 57 hatchlings. Increased monitoring will provide a better understanding of the use; and management is expected to increase the likelihood of additional nests insuitable habitat.

## 4.12 Native Plants

Native Hawaiian plants arrived to the archipelago via natural means such as wind, water, or birds. According to Wagner et al. (1999), the native Hawaiian flora is comprised of roughly 956 species within 87 families. Approximately 89 percent of these species are endemic (found only in Hawai„i), while the remainder are indigenous (naturally found in Hawai„i and elsewhere). Since their establishment, populations of Hawai„ï‘s native vegetation have greatly declined. Few native plants have escaped the impacts of urbanization and agriculture on the coastal and lowland habitats. As a result, recent surveys conclude that 75 percent of the native plant communities in these habitats are considered to be rare. Coastal alterations such as agriculture, residential developments, recreational parks, military installations, golf courses, and roads, have permanently displaced much of the native flora. With expansion of the Refuge, protection and outplanting will improve the native plant diversity and distribution (Cuddihy and Stone 1994).

## 4.12.1 Naupaka Kahakai (*Scaevola taccada*) or Beach Naupaka

Naupaka are indigenous shrubs that grow from 3-10 feet tall along coasts throughout the tropical Pacific and Indian Oceans. They have bright green succulent leaves with fragrant white flowers that appear to have split in half with five petals remaining on one side.

*Flowers and fruit of naupaka kahakai*
*Laura Beauregard/USFWS*

Part of the coastal dunes and scrub/shrub communities, naupaka kahakai provide cover and nesting substrate for seabirds and shorebirds. It is abundant and naturally occurring on the Refuge.

This species is the only non-endemic naupaka, and the only one to produce white fruit in the Hawaiian Islands. The pulpy marble-sized fruits tolerate salt water and float on the ocean currents for dispersal to other islands. Mixed with salt, the fruit or root bark of naupaka kahakai was used for cuts, skin diseases, and wounds (Ka,ₒiakamanu 2003).

## 4.12.2 ‘Ilima (*Sida fallax*) or Yellow Ilima

One of the most common native species found in Hawaiian coastal areas, ,ₒilima have yellow-orange flowers with five petals. The ground-hugging plant has heart-shaped 1-inch long slivery-green leaves. Individual plants of this species vary greatly in height, density of hairs, leaf size and shape, and flower color and size. The Refuge anticipates expansion of the species into additional areas of the Refuge as projects to remove pest plants for habitat restoration are implemented.

*‘Ilima Laura Beauregard/USFWS*

The yellow ,ₒilima is the official flower of the Island of O,ₒahu; about 1,000 blooms are used to create a single lei. Hawaiians also used the plant for medicinal properties. Pregnant women consumed its juice and flowers prior to giving birth to a child. The root bark mixed with the plantʻs blooms was used as an asthma remedy (Walther 2004).

## 4.12.3 Hala (*Pandanus tectorius*) or Screw-pine

Hala is a small tree growing 20-30 feet in height and from 15-35 feet in diameter. The trunk is stout and the branches grow at wide angles to it. It has distinctive long blade-like leaves (lau hala) about 2 inches wide and over 2 feet long. Most varieties have spines along the edges and on the midribs of the leaves. The leaves are spirally arranged toward the ends of the branches and leave a spiral pattern on the trunk when they fall. These trees develop aerial prop roots (ule hala) at the base of the trunk and sometimes along the branches. It occurs in coastal sites and on the low elevation slopes of mesic valleys further inland to 2,000 feet elevation, and has been identified as a potential roosting site for ,ₒōpe,,apeₒ,a. The Refuge anticipates restoring hala as a component of native habitat restoration projects within the expansion lands (Walther 2004, DOFAW 2005).

Female hala produce a large, segmented fruit somewhat resembling a pineapple. Male trees produce large clusters of tiny, fragrant flowers surrounded by white to cream-colored bracts. There are four types of hala based on color of fruit: common hala is yellow, hala ʻula is orange, hala lihilihi ʻula is red fading to yellow, and hala pia is small and pale yellow. Men from Kahuku were identified by lei of the orange hala fruit which they wore by order of their chief when they left their ahupuaʻa (Wilcox 1975, Hensley 1997, Wagner 1990).

*Hala grove Laura Beauregard/USFWS*

Historical accounts and legend emphasize the hala groves that covered the coastal plain. A Hawaiian chant describes the native hala of Kahuku (Elbert 1965:280-281):

| | |
|---|---|
| *A kukui au a Kahewahewa* | As I reported to Kahewahewa |
| *Ku au nana i laila,* | I stood and gazed, then |
| *Haloiloi kuu waimaka e uwe.* | Tears filled my eyes causing me to weep. |
| *Nani na hala ka oiwi o Kahuku,* | How beautiful are the hala, native trees of Kahuku, |
| *I ka lawe a ka makani he mikioi.* | As they are fanned by the Mikioi wind. |

## 4.13 Invasive Species

For the purpose of this CCP, an invasive species is defined as a species whose migration and growth within a new range is causing detrimental effects on the native biota in that range. Mammals, amphibians, invertebrates, and plants can all be considered invasive. These species become invasive because their population and growth are no longer balanced by natural predators or biological processes that kept them in balance in their native ecosystems. In the absence of these restraints, invasive species have the potential to compete with native species for limited resources, alter or destroy habitats, shift ecological relationships, and transmit diseases. Native species as well as nonnative species can become invasive when their natural ecosystem is out of balance.

Invasive species are one of the most serious problems in conserving and managing natural resources. In particular, the ecological integrity of Pacific Island environments is greatly threatened by invasive species. Hawaiʻi, which existed in isolation for millions of years, is an exceptionally ideal environment for these species. Most native species lost their natural defense mechanisms and are more vulnerable to introduced species (Pattison et al. 1998, Ikuma et al. 2002, Middleton 2006).

## 4.13.1 Mammals

*Black rat © Jack Jeffrey*

### 4.13.1.1 Rat (*Rattus* spp.)

Three pest rat species are found throughout the Hawaiian Islands. Polynesian rats arrived from the central Pacific 1,500 years ago with the Polynesians; Norway rats reached the Hawaiian Islands after the arrival of Captain Cook in the 1770s; and black rats most likely arrived in the 1870s. It is estimated that these three species have populated nearly 82 percent of the major islands.

Black and Polynesian rats can be found from 0-10,000 feet. Norway rats are restricted to areas below 6,000 feet. Polynesian rats and Norway rats nest exclusively in terrestrial habitats, while black rats are arboreal nesters. This nesting difference may contribute to a larger population of black rats in Hawai„i due to the presence of nonarboreal mongoose predators (Tobin and Sugihara 1992, Hays and Conant 2007).

All three species in Hawai„i are known predators of eggs, nestlings, young, and occasionally adults of endangered waterbirds, seabirds, migratory shorebirds, and forest birds. Ground- and burrow-nesting seabirds are particularly vulnerable to rat predation, even by the arboreal black rat. Rats also consume plants, insects, mollusks, herpetofauna, and other invertebrates. Because these species are also eaten by birds, a reduction in these populations may indirectly affect avian populations (Olson and James 1982, Harrison et al. 1984, Brisbin et al. 2002, Engilis et al. 2002, Mitchell et al. 2005).

The use of snap traps and ground-based application of diphacinone rodenticide to control rats in the main Hawaiian Islands has shown a positive effect in native bird survival. Rat control is conducted year-round at the James Campbell NWR with various methods including the use of rodenticide placed in bait stations, live traps, and snap traps.

### 4.13.1.2 Small Indian mongoose (*Herpestes javanicus*)

*Mongoose on the prowl © Chuck Babbitt*

The small Indian mongoose was intentionally introduced to numerous island ecosystems during the 1800s and 1900s and has since expanded to large portions of Asia, Africa, Europe, Oceania, and the Americas. In 1883, the species was introduced to the main Hawaiian Islands as a biocontrol agent against rats in sugarcane fields. The mongoose inhabits all habitat types from 0-10,000 feet on the islands of Hawai„i, Maui, O„ahu, and Moloka„i. In other areas of the world, mongooses appear to avoid wet areas; however, in Hawai„i, dense populations of mongooses are concentrated in wet habitats.

The home range of a female in Hawai„i is about 3.5 acres, and the main reproductive period occurs February-August. The high density of mongooses in the Hawaiian Islands is due to abundant food and the lack of natural predators. They are voracious omnivores, consuming insects, reptiles, mammals, amphibians, crabs, plants, and birds. In Hawai„i, mongooses are diurnal predators that

primarily eat invertebrates and secondly small mammals. They are a major threat to any ground dwelling and nesting species in Hawai,,i. These mammals are known to eat eggs, young, and adults of endangered Hawaiian waterbirds, various seabirds, and migratory shorebirds. In addition, mongooses are known to consume young honu (Tomich 1986, Staples and Cowie 2001, Mitchell et al. 2005, Hays and Conant 2007).

Mongoose populations are managed using traps and diphacinone rodenticide. Since mongooses are a constant threat to waterbirds, year-round control has been conducted on the Refuge since 2004.

#### 4.13.1.3 Cat (*Felis catus*)

Cats arrived in Hawai,,i in the early 1800s on European ships and are now found on all the main Hawaiian Islands from 0-10,000 feet. They are frequently observed on the Refuge and are occasionally caught in our trapping program.

*Neutered and released cat with ‘alae ‘ula*
*© Michael Walther*

Cats are natural hunters with their sharp teeth; the upper teeth overlap the lower, giving them a firm grasp to shake or tear prey to death. Food habits of cats in Hawai,,i include insects, centipedes, crustaceans, lizards, mice, rats, bird eggs, birds, and ,,ōpe,,ape,,a (Scott and Thomas 2000, Brisbin et al. 2002, Engilis et al. 2002, Mitchell et al. 2005).

#### 4.13.1.4 Pig (*Sus scrofa*)

In the wetlands at James Campbell NWR, pigs have trampled across mudflats and other habitats used by endangered and migratory waterbirds. Their mere presence creates a disturbance to all environments of the Refuge. Uncontrolled, they have the potential to degrade wetlands, reduce nesting and fledgling success of endangered waterbirds, and perpetuate spread of invasive plants, mitigating our efforts to enhance a variety of habitats on the Refuge.

*Pigs at Punamanō  Mike Sibernagle/USFWS*

Impacts to ecosystems can take the form of decreased water quality, increased propagation of pest plant species, increased soil erosion, modification of nutrient cycles, and damage to native plant species. Rooting, trampling, and compaction influence plant regeneration, community structure, soil properties, nutrient cycling, and water infiltration. Pigs may induce the spread of pest plant species because these plants typically favor disturbed areas and colonize more quickly than many native plants. Habitat damage is particularly important in wet areas where plant communities and soils tend to be more sensitive to disturbance. Wild pigs can be predators of ground-nesting birds, although the impact of this predation on the populations of ground-nesting birds is yet unclear (Seward et al. 2004, Kaller and Kelso 2006)

#### 4.13.1.5 Dog (*Canis lupus familiaris*)

*Dogs running through Ki'i Unit*
*Mike Silbernagle/USFWS*

The dog is a domesticated form of the gray wolf, a member of the Canidae family of the order Carnivora. Abandoned, escaped, or pet dogs allowed to run loose can cause great harm to native species and ecosystems. Dogs have caused terrible damage to native ground-nesting seabird colonies. In 2008, almost 90 wedge-tailed ,,ua,,u kani birds were killed by a pack of dogs at the nearby Kahuku Golf Course and in 2006, dogs killed nearly 180 ,,ua,,u kanichicks at Ka,,ena Point. Dogs typically attack a large number of birds in a single incident by grabbing and shaking the birds around with their mouths and leaving them for dead before heading to another nest or burrow. The Refuge has documented cases of ,,alae ke,,oke,,o and koloa maoli killed by dogs. Fencing is our primary means to keep dogs off the Refuge.

## 4.13.2 Birds

*Cattle egret © Michael Walther*

**Cattle egret (*Bubulcus ibis*)**

The cattle egret was introduced to Hawai,,i in 1959 from Florida for insect control on cattle and has become widespread. Rookeries were documented on Ni,,ihau, Kaua,,i, O,,ahu, Hawai,,i Island, Moloka,,i, Lana,,i, and Maui by the mid-1980s. One of the largest and oldest known rookeries is on O,,ahu near Kahuku. The actual roost site has moved to different sites over the years, and in 1982 this roost contained over 3,000 birds. A roost located on a parcel of land being acquired and added to the Refuge has been surveyed for several years and numbers have ranged from 100-1,800 birds. A survey conducted in 2010 yielded no birds at the roost/rookery.

Its diet primarily consists of grasshoppers, crickets, spiders, flies, frogs, and nocturnal moths, but the bird will also consume prawns, mice, crayfish, and the young of native waterbirds. Cattle egrets have been documented taking chicks of all endangered waterbirds species occurring on the Refuge. If numbers increase and predation on endangered waterbirds exceeds our target limit, population control measures as identified in the IPM would be implemented (Brisbin et al. 2002, Engilis et al. 2002, Hawaii Audubon Society 2005).

## 4.13.3 Amphibians

Nonnative amphibians also have a negative effect on native Hawaiian species. Recent radio transmitter studies at James Campbell NWR provide conclusive evidence that certain nonnative amphibians are key predators of juvenile Hawaiian waterbirds.

### 4.13.3.1 Cane toad (*Bufo marinus*)

Cane toads or Pacific giant toads, which are native to Latin America, have a broad geographic range that includes a majority of the Pacific region. The toads were brought to the Hawaiian Islands in 1932 to control insect pests. Both wetland units are infested with cane toads. The adults only require water for breeding, an event which results in thousands of eggs per mating occurrence. Cane toads are active at night and primarily feed on cockroaches, crickets, grasshoppers, grubs, earthworms, slugs, spiders, centipedes, and snails. In addition, these highly invasive amphibians could be a potential predator of endangered waterbird eggs and young (Yamamoto and Tagawa 2000, Staples and Cowie 2001).

*Cane toad Laura Beauregard/USFWS*

### 4.13.3.2 North American bullfrog (*Rana catesbeiana*)

North American bullfrogs were brought to Hawai„i in the late 1800s. They now occur on six of the main Hawaiian Islands, including the Refuge, where they have been identified as a major predator of ae„o chicks. They also prey on chicks of other endangered waterbirds. Nocturnal predators, they will ambush and eat just about anything they can fit in their ample mouths, including insects, mice, fish, and birds. They sit quietly and wait for prey to pass by, then lunge with their powerful hind legs, mouths open wide. Bullfrogs compete with waterbirds for food. Crayfish are an important food item for „alæ ke„oke„o and examination of bullfrog stomach contents indicates crayfish are also taken regularly. Control measures on the Refuge include water level management, live trapping, and shooting.

Bullfrogs can reach 8 inches in length, with males weighing up to 1 pound. Typically green or gray-brown with brown spots; they have easily identifiable circular eardrums, or tympanum, on either side of their heads. The bullfrog‟s hind feet are completely webbed except for the last joint of the largest toe. The bullfrog‟s call is a deep “jug-o-rum” or “br-wum” bellow, made day and night, and can be heard up to ¼-mile away. In breeding season, the throat of the male is yellow, whereas the female‟s is white. Unlike other frogs, it spends most of its time in water from where it also does most of its hunting (National Aquarium 2010).

*North American bullfrog Mike Silbernagle/USFWS*

## 4.13.4 Invertebrates

Although the Hawaiian Islands support a large number of native invertebrates, wide arrays of pest invertebrates have invaded marine and freshwater habitats. Between 20-30 species of introduced snails are believed to have established themselves on the Hawaiian Islands (Staples and Cowie 2001).

### 4.13.4.1 Apple snails (*Pomacea* spp.)

Five species of nonnative apple snails occur in the continental U.S. In Hawai„i, only four species have established, including *Pomacea canaliculata, P. bridgesii, P. paludosa*, and *Pila conica*. They were intentionally released into taro fields for their potential human food resource. All four species have a similar appearance making the species difficult to distinguish. The Pomacea species in Hawai„i are primarily herbivores that consume aquatic and semi-aquatic vegetation. The presence of *P. canaliculata* can be detected by the snail‟s large pink egg masses laid above water on vegetation, rocks, or any rigid surface (Yamamoto and Tagawa 2000, Staples and Cowie 2001).

Of the four species, *P. canaliculata* is the most serious threat to wetland ecosystems and agriculture (taro and watercress) throughout the State. This apple snail is the most voracious plant eater. Plant consumption causes shifts in ecosystem conditions and function. During feeding, *P. canaliculata* may consume most of the plant or make cuts, causing damaged plants to be highly susceptible to disease. It is unknown to what extent apple snails impact natural wetland vegetation in Hawai„i. Although P. *canaliculata* is a freshwater snail, it can tolerate low levels of salinity. It is sufficiently tolerant to sea water to survive long enough to be carried by currents from one stream mouth to another (Levin and „Onipa„a Nā Hui Kalo 2006, Yamamoto and Tagawa 2000, Rawlings et al. 2007).

Apple snails prefer slow moving, shallow water areas. They cannot tolerate cold waters, but can survive significant amounts of time out of water and are able to undergo dormancy periods by burying in mud. Field tests have shown that fields submerged for longer than 48 hours with brackish water will kill apple snails; however, this management technique will also change soil productivity toward brackish water adapted vegetation. Field flushing with salt has successfully killed snails in some ponds at James Campbell NWR, but snails are still present in ditches and drainages (Cowie 2002, Levin and „Onipa„aNā Hui Kalo 2006).

### 4.13.4.2 Ants

Hawai„i is one of the few places on Earth believed to harbor no native ant species. Today, at least 47 ant species in 7 subfamilies and 24 genera have become established. Ants are a growing concern since they can have negative effects on native and endangered plants and animals. Ants are known to attack, injure, or kill young birds. Ants are also implicated in having negative effects on native and endangered plants. Control of ants has potential on the Refuge to protect trust resources. The Service is currently studying the efficacy of various baits and approved toxins on pest ants on O„ahu. It is anticipated that over the course of this CCP, the Refuge will adopt IPM methods to control ants based on the results of these studies

## 4.13.5 Plants

At the ecosystem level, pest plants have been shown to be capable of changing fire regimes, altering nutrient cycling patterns, and modifying the surface runoff of water. Pest plants can physically displace native species, and/or supersede them in competition for water, nutrients, or other limited

resources. Nonnative plants can also be vectors and hosts for introduced pests and diseases to which the native species lack natural defenses (Jui Min et al. 2007).

Almost half the flora of the Hawaiian Islands is comprised of naturalized nonnative plants, approximately 1,100 species. According to Staples et al. (2000), invasive plants in Hawai„i share the following biological and reproductive characteristics:

- Adaptable to and capable of thriving in different habitats;
- Tolerant of variable conditions (such as light, temperature, moisture);
- Fast growing;
- Tolerant of disturbance;
- Easily dispersible to new localities by seeds, fruits, spores, or vegetative parts;
- Produce small seeds/spores early in life;
- Long reproductive periods; and
- Dispersed by animals and with no special germination requirements.

The control and eradication of pest plants has been the top priority of natural resource managers in Hawai„i. In the wetland habitats of the Refuge, invasive plant species can drastically reduce the value of wetland habitat to native species. Pest species outcompete more desirable plant species here, as well as invade open water and mudflat habitats. In addition, the high biomass characteristic of invasive grasses produces a high amount of fuel for fire. At James Campbell NWR, a combination of control techniques are employed for pest plant removal including chemical, mechanical (hand and tractor), prescribed burns, and water level manipulations. The following five introduced plant species are of major concern on the O„ahu wetland refuges.

#### 4.13.5.1 California grass (*Brachiaria mutica*)

California grass (Family-Poacaeae) is a sprawling perennial with culms up to 19 feet long and rooting at the nodes. Stolons and leaf sheaths are densely hairy. It occurs pantropically as a pasture grass and its native range is unknown, although it is suspected to have originated in sub-Saharan Africa. California grass occurs in aquatic environments such as the openings of wet forests, marshes, and other open water areas. It is reported to be well adapted to a wide range of soil conditions (sandy to clay) and tolerates moderate shade but prefers full sun (Tropical Forages 2005).

*California grass Mike Silbernagle/USFWS*

It grows prolifically in wet swampy habitats, but it can also withstand severe drought. In addition to displacing native plants, California grass alters and destroys aquatic environments, causing a reduction in bird habitat. The grass also interferes with stream flow and poses a nuisance to marine navigation when rafts of the grass float out to sea. The Hawai„i-Pacific Weed Risk Assessment is a research project conducted by the University of Hawai„i and the USDA Forest Service to identify plants that pose a high risk in Hawai„i and other Pacific Islands. The assessment of California grass reflects the species is “documented to cause significant ecological or economic harm in Hawai„i” (Stone et al. 1999, Motooka et al. 2003).

An on-site study determined that this species can grow 6 feet a month at James Campbell NWR. Intensive control measures for California grass on the Refuge include mechanical, chemical, and prescribed fire as described in detail in the IPM (Appendix F).

#### 4.13.5.2 Khaki weed (*Alternanthera pungens*)

*Khaki weed Mike Silbernagle/USFWS*

Khaki weed (Family-Amaranthaceae) is a perennial prostrate herb, sometimes rooting at the nodes. Flowers are sessile; bracts are approximately 0.16 inch long, tipped with a 0.08-0.12 inch-long spine. Khaki weed is native to Venezuela, Brazil, Peru, and Ecuador, and is widely naturalized elsewhere in the world (Wagner et al 1999, USDA-GRIN Online Database).

In Hawai,,i it was first recorded on O,,ahu in 1959 and has become naturalized on O,,ahu, Moloka,,i, and Hawai,,i. It is common in beach parks and other low elevation, dry, disturbed areas. Khaki weed is easily dispersed by numerous spiky, straw-colored burrs that are transported by animals, machinery, or water. The large and deep woody taproot allows the plant to tolerate drought and makes control difficult. These traits contribute to the plant"s invasive ability. To control khaki weed, the Refuge conducts spot spraying and maintains a dense groundcover of lowgrowing grasses or other desireable species which prevent germination and spread (Wagner et al. 1999, Smith 2002).

#### 4.13.5.3 *Pluchea* spp.

*Pluchea indica Mike Silbernagle/USFWS*

*Pluchea* spp. (Asteraceae) is comprised of two shrub species in Hawai,,i-Indian marsh fleabane (*P. indica*) and sourbush (*P. carolinensis*) – and a hybrid of the two species. Indian fleabane is an erect shrub up to 6.6 feet tall. It is native to temperate and tropical Asia and northern Australia and is naturalized elsewhere. In Hawai,,i, it occurs in lowland, coastal habitats such as wetlands and fishponds. Initially recorded on O,,ahu in 1915, Indian fleabane has been identified on Maui, O,,ahu, Kaua,,i, and Ni,,ihau. It prefers marshes and saline soils (Motooka et al. 2003, USDA, GRIN Online Database).

Sourbush is an erect aromatic shrub native to parts of North and South America. The species has naturalized in Hawai,,i, Guam, Taiwan, Africa, and other tropical and Pacific areas. It can grow in poor soil conditions; however, it cannot withstand shade and severe competition from brush and grass. In dry habitats, the fast-growing shrub can form thickets. In Hawai,,i, sourbush has spread to all the main Hawaiian Islands since its arrival in the 1930s. This shrub is able to grow in a wide array of habitats, ranging in distribution from dry coastal areas to open forests at 2,953-feet elevation. The plant seeds prolifically and the seeds are easily dispersed by wind (Mueller-Dombois and Fosberg 1998, Wagner et al. 1999).

Pluchea will outcompete native sedges on the Refuge, reducing forage and nesting habitats for birds. They tend to harbor huge nests of paper wasps, which are a hazard to Refuge staff and the public. The Refuge uses mechanical, chemical, and prescribed burning techniques to control this pest species.

#### 4.13.5.4 California bulrush (*Schoenoplectus californicus*)

California bulrush is a perennial sedge in the Cyperaceae family. This rhizomed water plant is found in marshy areas from southern and western North America to South America. It has tall, thin, dark green stems which are usually triangular in cross-section and woolly, bristly tan or brown flowers in panicle inflorescences. It has characteristics common in the sedge family, such as creeping. It is intolerant of shade, but can spread rapidly by vegetative means (Wagner et al. 1999, NRCS 2008).

*California bulrush at Punamanō Mike Silbernagle/USFWS*

California bulrush has almost covered the wetland habitat at the Punamanō Unit, significantly decreasing the value to waterbirds. This weed is highly successful in Hawai,,i compared to the continental mainland due to the lack of a winter dry cycle. The most common tactics used in the Refuge to control it are burning, tilling, and use of herbicides. Flooding has also been employed as a removal tactic during the early stages of growth, however, this method decreases bird habitat by changing pond salinities. Other proposed methods of removal include helicopter-applied herbicide and use of an amphibious excavator.

#### 4.13.5.5 Silverhead *(Blutaparon vermiculare)*

Silverhead is a perennial herb in the Amaranthaceae family. It is native to Africa, the southern states of North America, and South America. This species forms dense groundcover with prostrate stems and ascending branches that flower year round, outcompeting native plants and degrading wetland features important to endangered species recovery. Silverhead was added as a new State record to naturalized flora in 1994 after being found in an aquaculture facility at the end of the old runway in 1991. At James Campbell NWR, this species occurs primarily along pond edges (Wagner and Herbst 1994).

The primary control method used on the Refuge is chemical spraying, as detailed in the IPM (Appendix E).

*Silverhead pest plant Mike Silbernagle/USFWS*

## 4.13.6 Diseases

### 4.13.6.1 Fibropapilloma tumor disease

Fibropapillomatosis (FP) of marine turtles is a debilitating neoplastic disease with a global distribution that was originally described in honu in Hawai,,i in 1958. The prevalence in certain coastal habitats has increased or remained high since systematic surveys were started in the early 1980s. These tumors can result in debilitation and even death to individual animals. The Refuge will monitor the frequency and severity of FP occurring on honu observed along the shoreline. Research continues as to the cause and potential future remedies for this disease (Herbst 1994, Balazs 1991).

### 4.13.6.2 Avian botulism

Avian botulism is a paralytic disease caused by ingestion of a toxin produced by the bacteria, *Clostridium botulinum*. This bacteria is widespread in soil and requires warm temperatures, a protein source and an anaerobic (no oxygen) environment in order to become active and produce toxin. Decomposing vegetation and invertebrates combined with warm temperatures can provide ideal conditions for the botulism bacteria to activate and produce toxin.

Birds either ingest the toxin directly or may eat invertebrates (e.g., chironomids, fly larvae) containing the toxin. Invertebrates are not affected by the toxin and store it in their body. A cycle develops in a botulism outbreak when fly larvae (maggots), feed on animal carcasses and ingest toxin. Ducks that consume toxin-laden maggots can develop botulism after eating as few as three or four maggots.

Outbreaks can occur most anytime on the Refuge, but typically occur during the summer months during warm to hot weather. Thousands of birds have been know to die during a single outbreak in areas of high waterfowl concentrations. In Hawai,,i there is no seasonal pattern to this disease.

Botulism is one of the few wildlife diseases we can actually manage effectively. Although we do not know all the environmental triggers that cause *Clostridium botulinum* to start producing toxin, we do know that if mortalities are detected early enough, certain management techniques, if implemented quickly, can rapidly stop and mitigate the magnitude of waterfowl mortality. The Refuge uses carcass pick up and removal as well as water level management in its efforts to minimize impacts of this disease. Because animal carcasses are an excellent source of protein, removing them reduces the resources the bacterium needs to produce toxin and can help reduce or eliminate toxin production. Draining or flooding the wetland can change the environmental conditions sufficiently so as to stop the production of toxin.

# 4.14 Habitats

The units of James Campbell NWR are located on lowland coastal areas. On the island of O,,ahu, these habitats have been severely altered by a variety of factors including pest species and land use changes. Continued threats to these habitats remain and conservation efforts are needed to improve habitat conditions.

## 4.14.1 Coastal Dune/Beach Strand

*Beach strand Laura Beauregard/USFWS*

Coastal habitats are lands between 0- 985 feet in elevation that are typically vegetated with strand species. The area paralleling the shoreline, also referred to as the beach strand, includes beaches, coastal dunes, and the zone immediately inland of the dunes. Beaches are the most seaward portion of the coastal region and are composed of sand or other loose materials that are constantly exposed to waves and tides. Coastal dunes are ridges or mounds of sand located immediately landward of the beach. These mounds are formed by an accumulation of windblown sand that is trapped via obstacles such as vegetation. Dunes are dynamic features that erode during periods of high waves (a process termed scarping) and rebuild when heavy wave action subsides. The coastal dune ecosystem is an integral part of the beach system in Hawai,,i; it functions as a natural, elevated buffer against erosion, flooding, high waves, storms, tsunamis, and other coastal hazards (Wagner et al. 1999, Char and Balakrishna 1979, University of Hawai,,i 2005).

The natural dune and coastal beach strand habitat along the Kahuku coastal plain, including the seaward portion of James Campbell NWR, is one of last remaining undeveloped coastal dune areas on O,,ahu. Coastal communities on the windward sides of the Hawaiian Islands are exposed to a variety of harsh conditions including strong trade winds and high surf. As a result, vegetation tends to be low and wind sheared. Strand vegetation on sandy or dune areas typically includes ,,aki,,aki, pōhuehue, hinahina, naupaka, pōhinahina, Bermuda grass, nanea, alena, *Reichardia picroides*, ,,ohai, nama, and Australian saltbush (Mueller-Dombois and Fosberg 1998).

In addition to providing habitat for native flora, the coastal dune areas at James Campbell NWR provide resting habitat for the endangered ,,īlio-holo-i-ka-uaua, and nesting habitat for threatened honu. Dunes in Kahuku provide habitat for seabirds and shorebirds including the kōlea and kioea, two shorebird species designated as a high conservation concern. These coastal dune areas formerly provided nesting areas for the endemic pueo. Pueo are common on Maui, Kaua,,i, and Hawai,,i; however, the State of Hawai,,i has listed it as an endangered species on O,,ahu (Hawaii Audubon Society 2005).

Recreational and coastal development pressures have severely impacted coastal dunes throughout the State of Hawai,,i and the Island of O,,ahu. Commercial and residential developments along the coastline level the dune environment. Grading and landscaping alter the naturally occurring topography and ecology of dunes. Soil filling, in order to support nonstrand vegetation, compacts and

traps dune sands and sand that is removed by waves cannot be replaced. This trapping causes a continual decrease in sand and loss of the beach environment. In addition, the continuous trampling by vehicles and pedestrians on the dunes causes erosion and sand movement. Vogt (1979) found that fewer than 10,000 pedestrians walking over sand dunes during a single season can eliminate dune vegetation and result in erosion. Because the beach area in Hawai„i is attractive to both visitors and residents, pedestrian traffic has a significant impact on these areas. Offroad recreational vehicles also flatten dunes and impact strand species (Tabata 1980, University of Hawai„i and Maui Planning Department 1997, DLNR 1999).

With the purchase of the expansion area, the Service plans to restore the coastal dune ecosystem at the James Campbell NWR. Other dune restoration projects in Hawai„i, such as Kama„ole and Memorial Beach Park, significantly enhanced the recreational value of the beach and upland areas. The State of Hawai„i Coastal Erosion Management Plan (1999) lists the restoration of dune systems as a major component to improve Hawai„i's coastal region. Dune management tools include planting native coastal vegetation; controlling pest plants; prohibiting vehicles (including all-terrain vehicles); and regulating public access.

## 4.14.2 Wetlands

Wetlands typically have three distinguishing characteristics: (1) hydrological conditions that exhibit inundation or saturation; (2) unique hydric soil conditions; and (3) hydrophyte vegetation that is adapted to wet conditions. Although wetlands typically share these common characteristics, the precise definition of a wetland varies among managers, landowners, and agencies. The Service defines wetlands as "lands transitional between terrestrial and aquatic system where the water table is usually at or near the surface or the land is covered by shallow water." According to this definition, unvegetated areas including beaches, mudflats, and ponds can be considered wetlands. The USACE and EPA define wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstance do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Because of these varied definitions, three indicators are used to assess whether an area is considered a wetland: hydrology, vegetation, and soils (Mitsch and Gosselink 1993, Erickson and Puttock 2006).

*Punamanō wetland George Fisher/USFWS*

In the Ko„olauloa District, we find the following wetlands: Turtle Bay Golf Course Ponds, Kuilima Mitigation Pond, Punaho„olapa Marsh, James Campbell NWR, Kahuku Aquafarms, the Airstrips Ponds, Kahuku Prawn Farm, Lā„ie Aquaculture Farm/Po„ohaili Wetlands, Hau„ula, Punalu„u Prawn Farm, Kahana State Park/Huilua Pond, and Ka„a„awa Wetlands. Wetland areas at the Refuge are especially important (in regard to waterbird and seabird habitat) due to the significant management activities that occur. Small remnants of the Punaho„olapa wetland, located between the Punamanō Unit and the Turtle Bay Resort, have also been noted as providing habitat for Hawaiian waterbirds (DPP 1999, Levin and „Onipa„aNā Hui Kalo 2006).

In addition to providing habitat, wetlands are critical components of an area‟s hydrology by serving as retention areas for flood waters. These areas help reduce the velocity of water and decrease erosion through sediment attenuation. Reduced siltation results in decreased turbidity of ports, harbors, and rivers. Another value that wetlands provide is trapping pesticides and fertilizers, such as phosphate and nitrates. By filtering these pollutants, wetlands improve water quality in streams and marine areas. Wetlands also function as a groundwater recharge area for potential human use. Finally, the aesthetic qualities of wetlands offer recreation and leisure areas for tourists and local residents (USFWS 1984, Erickson and Puttock 2006).

Wetland management at James Campell NWR will expand to more functional acreage for endangered, migratory, and resident bird species with the acquisition lands.

### 4.14.3 Exposed Coral Shelf and Anchialine Pools

*Exposed coral shelf Mike Silbernagle/USFWS*

The exposed coral shelf consists of coral outcropping or cemented calcareous sand on the island of O,,ahu. The coral reefs formed in shallow ocean water during the time the ocean was at a higher level. Small areas of coral outcrop are exposed on the ocean shore, on the coastal plains, and at the foot of the uplands.

Sinkholes in the coral shelf often contain anchialine pools in Hawai,,i. Anchialine pools are exposed portions of the groundwater table that have a subsurface connection to the sea. The Hawai,,i Department of Health defines anchialine pools as: "…coastal bodies of standing waters that have no surface connections to the ocean but display both tidal fluctuations and salinity ranges characteristic of fresh and brackish waters, indicating the presence of subsurface connections to the water table and ocean." Anchialine pools are known occur in two locations on the Refuge. Additional pools may be discovered as habitat restoration projects are implemented in the expansion area (Maciolek 1983, Char and Balakrishna 1979, Craft et al. 2008).

These habitats represent a unique coastal ecosystem dominated by bacterial mats, algae, emergent aquatic plants, mollusks, and crustaceans under natural, undisturbed conditions. Anchialine ponds are considered to be windows into a far more extensive subterranean brackish water ecosystem that is home to a unique assemblage of native species. They have the potential to harbor four species of endemic anchialine shrimp that are listed as candidate endangered species: *Metabetaeus lohena, Vetericaris chaceorum, Palaemonella burnsi,* and *Procaris hawaiiana* (Maciolek and Brock 1974).

## 4.14.4 Coastal Shrubland (Scrub/Shrub)

Scrub/shrub areas are dominated by woody vegetation less than 20 feet tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. Approximately 22 percent of native Hawaiian plant species are found in this ecoregion. Coastal and lowland dry shrublands occur on the lowest leeward slopes of the higher Hawaiian Islands.

*Scrub/shrub habitat Mike Silbernagle/USFWS*

Clearing and burning of lowland dry shubs began with the arrival of Polynesians and the last remnants are being destroyed today through continued development, expansion of agriculture and pasture, and burning. This habitat in the new expansion lands of the Refuge is currently dominated by pest species such as kiawe, ironwood, and koa haole (WWF 2010, Walther 2004).

Prior to human settlement, this scrub/shrub area was dominated by a dry forest with habitat for several forest birds, such as honeycreepers, fly catchers, flightless rails, other flightless birds (now extinct). Hawaiian dry forests have been reduced by 90 percent. Land utilization by the early Polynesians damaged portions of the Hawaiian landscape, but this was nothing compared to the devastation that followed with the introduction of herbivores. Cattle, sheep, goats, deer and the European pig were introduced by early European explorers in exchange for supplies. Because there were no natural predators, these herbivores devastated the natural ecosystems, pushing the rate of extinction (flora and fauna) to alarmingly high numbers (Kimura and Nagata 1980).

One of the most significant influences leading to the degradation and loss of native Hawaiian habitats has been the influx of pest plants. The Refuge plans to work with partners to restore a more natural scrub/shrub community through removal of invasive plants and outplanting of native plants that were part of the historic vegetative community. Where there is suitable substrate, we will determine the feasibility of establishing populations of the endangered ʻEwa hinahina and ʻākoko.

# Chapter 5. Outdoor Recreation, Social, and Economic Factors

## 5.1 Outdoor Recreation

The climate and geography of Hawai,,i make the islands a perfect location for outdoor recreation activities. The State Comprehensive Outdoor Recreation Plan (2008) was developed to guide planning, development, and management of these outdoor recreation resources. In addition, the eight regional Development Plans/Sustainable Communities Plans throughout the Island of O,,ahu identify local recreational goals.

As identified in the Administration Act, as amended, the Service identifies six general wildlife-dependent uses on national wildlife refuges: hunting, fishing, wildlife observation and photography, and EE and interpretation. Similar opportunities are available on lands managed by the State and City and County of Honolulu.

This section describes recreational opportunities in the areas surrounding James Campbell NWR, as well as recreational activities currently occurring at the Refuge units. Islandwide recreational demands and potential recreational opportunities are also discussed.

### 5.1.1 Federal, State, and County Recreational Parks

State parks are administered by the Hawai,,i Department of Land and Natural Resources (DLNR), Division of State Parks. The State park system on O,,ahu encompasses 22 parks covering approximately 9,900 acres. Special use permits are required for certain activities including group activities, pavilion usage, meetings, weddings, shows, community events, scientific research, and gathering of forest products.

The City and County of Honolulu, Department of Parks and Recreation (DPR) administers an additional 282 parks throughout O,,ahu comprising 5,314 acres. These parks are divided into two groups: Island-Based Parks and Community-Based Parks. The largest and most specialized parks (such as regional parks, beach and shoreline parks, beach and shoreline rights-of-way, nature parks and reserves, botanical gardens, golf courses, and zoological parks) are classified as Island-Based Parks. These parks are intended to serve the needs of all O,,ahu residents. The DPR suggests 8 acres of Island-Based Parks for every 1,000 persons. Community-Based Parks are smaller parks designed to provide recreation for more localized populations. These parks include district parks, community parks, neighborhood parks, and mini parks. The DPR uses a standard of 2 acres of Community-Based Parks for every 1,000 persons (DPP 2002, DBEDT 2009).

There are two State parks in the Ko,,olauloa region – Mālaekahana State Recreation Area (SRA) and Ahupua,,a O Kahana State Park. The Mālaekahana SRA is divided into two sections. The Kalanai Point portion is 0.6 mile north of Lā,,ie and the Kahuku portion is 1.3 miles north of Lā,,ie. Swimming, bodysurfing, fishing, and beach-related activities are permitted at this park. Ahupua,,a O Kahana State Park is located roughly 9.3 miles south of the Refuge between the communities of Kāne,,ohe and Lā,,ie. Recreational activities at the park include camping, hiking, and hunting in designated areas during weekends and holidays (Division of State Parks 2008).

## 5.1.2 Historic/Cultural Sites

O,,ahu has 151 State historic sites and 68 sites on the National Register of Historic Places. These resources have the potential to be recreational areas for local residents and tourists. There were 57 archaeological sites identified in the region of Ko,,olauloa during a survey in the 1930s. Many of these sites may have since been destroyed by urban development or agriculture activities. The sites closest to the Refuge are the Waikane stone at Kawela, the Kalaewila heiau at Kahuku Point, and the Wai,,apuka pool at Mālaekahana. Three additional archaeological/cultural sites occur in the community of Lā,,ie. These include the Paeo Fishpond, Nioi Heiau, and Laniloa Point, In addition to designated cultural sites, iwi, which are bones and other skeletal remains from traditional Hawaiian burials, are known to occur in sand dunes and sandy soils along coastal areas. Three such burials have been documented in the vicinity of the Refuge coastline as "inadvertent discoveries". This is when iwi have become exposed and discovered due to wind and water erosion (DPP 2002, Dougherty and Moniz-Nakamura 2005).

The Punamanō Unit is named for a legendary spring on the Refuge. The following is an account reported by J. Gilbert McAllister in his book *Archaeology of Oahu* (1933):

***The Punamanō Legend***

*One time when the people of Kahuku were fishing they caught a small manō (shark). Putting him in a calabash of water they carried him to their houses near the beach. Here he was cared for and put in larger and larger calabashes as he grew bigger. Finally having outgrown even the largest calabash that could be found, it was decided to place him in one of the pools of brackish water which came to be known as Punamanō (shark spring).*

*A man and woman living near the pool became the manō's guardians. They had lived in their grass huts with a breadfruit tree near the pool and taro and potato patches near the mountains for several years when the brother of the woman came to live with them. Sometime after, the man and woman went to the mountains to gather taro and potatoes. The brother, who was staying at home, thought that he would like to have some food prepared when they returned.*

*He climbed the breadfruit tree and gathered several, throwing the fruit into the water instead of on the ground, where it would have been bruised in the fall. After picking enough for a few days he descended the tree and gathered most of the fruit from the bank. Two had floated to the middle of the pond and he could not reach them. Now this man knew of the shark that lived in the water, but he had frequently bathed in the pool and no thought of fear crossed his mind as he swam to the breadfruit. He did not know, however, that his sister had warned the manō not to allow anyone to steal breadfruit when they were gone.*

*When the sister and her husband returned they could not find the brother. Neither was the manō to be found, but they saw the breadfruit floating in the pool and a reddish color to the water. They guessed what had occurred. For nearly a mile they followed the bloody trail until they came to the spring known as Punaho'olapa (restless spring). Not only was the brother never seen, but the manō has never been seen to this day.*

Although not designated as a historic site, a portion of the former World War II Kahuku Army Airfield is located within the new expansion lands. Classified as an auxiliary field, it had a very short lifespan, from 1942 until it was closed in the late 1940s. Ground troops were stationed in the

area to protect the airfield and man shoreline fortifications. It is documented that the 18th Air Base Group, 47th Pursuit Squadron was stationed there along with B-24s and B-17s that were based at Kahuku for short periods of time during World War II. Most of the buildings and support structures associated with the Kahuku Army Air Field have been removed. A portion of the old runway, a few scattered concrete pillboxes, storage bunkers, and antenna supports covered by low brush and debris can be found in the coastal shrubland (McKillop 2005).

### 5.1.3 Ocean Recreation

*Rough north shore surf Laura Beauregard/USFWS*

Ocean recreation in Hawai„i supports an $800 million industry. The Hawai„i Division of Boating and Ocean Recreation manages 14 small boat harbors, 1 deep draft harbor, and 4 launching facilities on the Island of O„ahu. The closest launch ramp to James Campbell NWR is located at Kahana Bay. Hale„iwa Harbor is the nearest small boat harbor. This harbor is located on the north shore region in Waialua Bay (DPP 2002).

The primary ocean recreation activities adjacent to the Refuge shoreline consist of fishing from the shore with poles and throw nets, catching ama crabs and he„e, and free-dive spearfishing. Due to rough ocean conditions year-round (windy, choppy surf, and shallow coral), surfing in the immediate vicinity of the Refuge is only an occasional activity conducted by a few individuals.

### 5.1.4 Wildlife Observation, Photography, Interpretation, and Environmental Education

The 18 wildlife sanctuaries and refuges on O„ahu encompass 700 acres. Opportunities for wildlife observation, photography, and EE are available at most of these areas, and private tour operators provide interpretation at some sites. Off the coast of the Ko„olauloa area, the public can engage in wildlife observation at five islets designated as State Seabird Sanctuaries.

*Wildlife viewing at the Refuge © ucdavis.edu*

Wildlife observation opportunities at the Ki„i Unit fluctuate with the nesting season of the waterbirds at the Refuge, especially ae„o. Public entry is limited between February and mid-July when birds are nesting and fledging. Following this time period, Refuge staff conduct intensive habitat maintenance work until mid-October. Seasonal tours of the Ki„i Unit are available after maintenance work until February 28. The public may access the Refuge by authorization from the Refuge Manager or by participating in scheduled tours. Guided tours by volunteer docents or knowledgeable birders occur on Thursdays and Saturdays by reservation only.

During the nonnesting season between 2009 and 2010, more than 1,200 individuals visited the Ki„i Unit of the Refuge. Two-thirds of these visitors were students participating in EE. This wetland education program has been occurring at James Campbell since 1985. Biweekly scheduled tours for the general public brought in the other visitors during the 2009-2010 nonnesting season. General public tours have an average of 12 people per tour, while EE tours have slightly over 30 individuals per tour.

## 5.1.5 Fishing

Recreational and subsistence fishing is an important activity to many residents of Hawai„i, and fishing tourism is also an important part of the economy. Recreational fishing is administered by the Division of Aquatic Resources within DLNR. No license is required for recreational saltwater fishing, which takes place all along the coastal areas near Kahuku. Typically, rod and reel poles are used; however, spearfishing and throw-nets are also popular. The most coveted reef fishes are uhu, ulua, and redfish. The closest public shore access locations are 1 mile south at Mālaekahana SRA and 4 miles north at the Turtle Bay Resort.

*Fishing along Refuge shoreline Mike Silbernagle/USFWS*

Current access to the Refuge coastal strand occurs by two primary means: (1) By entering from either end of the coastline along the public shoreline corridor; and (2) by crossing James Campbell Company land. Private access to the shoreline has occurred over many decades by persons and their invited guests that held leases on that land from the James Campbell Company. These leases will be terminated as this land is acquired by the Service and the associated private access will end as well. The Kahuku Village Association also allows contolled access for fishing to the public shoreline corridor on lands it controls near the Kahuku Golf Course. About 200 people pay an annual "fishing club" membership fee for this access.

## 5.1.6 Hunting

On O„ahu, hunting is permitted in 12 public hunting areas, covering 25,000 acres. The main species hunted are goats and pigs. Nonnative game birds are also hunted including the ring-necked pheasant, Japanese quail, three francolin species, and several dove species. Personnel engaging in hunting must possess a valid State of Hawai„i hunting license. A total of 8,249 hunting licenses were issued throughout the State in 2008. There are few game species (game birds and pigs) within the Refuge. Yearlong management actions for four endangered waterbirds and their associated habitat, coupled with low, scattered game populations on the Refuge, preclude a public hunting program. Based on the potential for direct harm to endangered waterbirds, the Refuge is closed to the public for hunting (DBEDT 2009).

# 5.2 Social and Economic Conditions

The purpose of this section is to address the local economy and social environment surrounding the James Campbell NWR, including population estimates and economic indicators. The Refuge is located within the County of Honolulu, next to the community of Kahuku.

## 5.2.1 Population

The total resident population of the Hawaiian Islands according to the 2010 census was 1,360,301. The Island of O,,ahu is home to 73 percent of this total. In terms of population density, Hawai,,i's 211.8 people per square mile in 2010 is 2.42 times the U.S. population density. According to the Hawai,,i Department of Business, Economic Development and Tourism (DBEDT), roughly 43 percent of the Hawai,,i population was born outside of the State of Hawai,,i. The ethnic composition of the City and County of Honolulu is diverse with the majority of the population identifying themselves as Caucasian, Hawaiian or part Hawaiian, Japanese, Filipino, or mixed ethnic background.

O,,ahu is divided into eight planning areas. Each area has a Development Plan which is adopted by City Council ordinance and administered by the Department of Planning and Permitting. James Campbell NWR is located within the Ko,,olau Loa planning area. As of the census of 2000, there were 2,097 people, 509 households, and 401 families residing in Kahuku. Pacific Islanders lead the racial makeup with 27.28 percent, 26.85 percent Asian, 11.06 percent White, 0.29 percent Black or African American, 0.14 percent Native American, 1.05 percent from other races, and 33.33 percent from two or more races. A total of 8.63 percent of the population is Hispanic or Latino of any race. (HCDA 2005, DBEDT 2010).

There were 509 households out of which 43.2 percent had children under the age of 18 living with them, 59.3 percent are married couples living together, 14.3 percent had a female householder with no husband present, and 21.2 percent were nonfamilies. The average household size was 3.96 and the average family size was 4.63. The median income for a household in 2000 was $39,135, in stark contrast to the islandwide median income of $70,010 (quickfacts.census.gov).

## 5.2.2 Education

Educational attainment is slightly higher on the island of O,,ahu compared to the rest of the State. In 2000, approximately 84.8 percent of the O,,ahu population 25 years and over had received a high school diploma. Furthermore, approximately 27.9 percent reported to have a Bachelor's degree or higher. The State averages during the same year were 84.6 and 26.2 percent, respectively (DBEDT 2010).

Within the University of Hawai,,i system (UH) are five community colleges and two universities on O,,ahu. In 2008, enrollment at UH Mānoa was 20,169 and at the West O,,ahu Campus was 1,140 students. Approximately 21,169 students were enrolled in the community colleges throughout O,,ahu. Total enrollment in private universities on O,,ahu (including Brigham Young, Hawai,,i Pacific, and Chaminade) in 2008 was 13,293. Brigham Young University is just 3 miles south of the Refuge with an enrollment of 2,500 students who represent over 70 different countries and cultures from the Pacific Rim, the U.S. mainland, and other parts of the world. (DBEDT 2009).

## 5.2.3 Economy

Hawai„i ‟s economy grew at an annual rate of 4.1percent between 2001 and 2006. Including the economic recession of 2008 and 2009, the economic growth rate in Hawai„i between 2000 and 2009 was 2.3 percent per year. Hawai„i is economically dynamic with diversified agriculture and manufacturing; strategically important to the global defense system of the United States (U.S.); a Pacific Basin transportation center; and a major tourism destination. The health of the State‟ s economy depends significantly on conditions in the overall U.S. economy and key international economies, especially Japan. State taxes are collected under a centralized tax system. The chief sources of the State‟ s revenue are a general excise tax, individual income taxes, and Federal grants-in-aid. The second largest source of income in Hawai„i is the Federal government, primarily through defense expenditures (DBEDT 2010).

Tourism is Hawai„i‟ s largest industry with the majority of visitors coming from the U.S. mainland, Canada, Australia, and countries of the Far East, particularly Japan. Most visitors to Hawai„i travel by air. The Honolulu International Airport on O„ahu; General Lyman Field on Hawai„i; and the Kahului Airport on Maui, are the major civilian airports capable of serving large-jet traffic. There are several smaller airports among the islands and a number of small private airfields and military airports throughout the State. Oceanic passenger ships also carry visitors through Honolulu, cruise ships travel from California to Hawai„i and Tahiti to Hawai„i, and there is also an interisland cruise line.

Hawai„i‟ s mild, year-round climate sustains many different types of agriculture, generating $2.9 billion to the State's annual economy and directly and indirectly providing 42,000 jobs. The Polynesian voyagers traveled to Hawai„i with plants such as taro, bananas, and other staples to sustain themselves. Agriculture began with small farms covering the islands, growing everything from sweet potato to rice. Fishponds were created along the coasts to raise fish and other seafood. The plantation era brought decades of the sugar and pineapple industries, expanding over thousands of acres of prime agricultural lands. Now, with the decline of the sugar industry, these agricultural lands are returning to a new era of small farms growing diversified agricultural products. Crops such as specialty fruits, coffee, macadamia nuts, flowers and foliage not only provide fresh produce and flowers to local markets, but also have become major exports to destinations around the world. The early fishponds have evolved into high-tech aquaculture ventures, farming varieties of fish, shrimp, lobster, abalone, and seaweed (HDA 2009).

Hawai„i has several hundred companies engaged in diversified manufacturing. Heavy-manufacturing plants, using raw materials for the most part imported from the U.S. mainland, include an oil refinery that produces a variety of petroleum products and chemical compounds, a steel mill manufacturing reinforcing bars; several cement plants, a concrete-pipe plant, and an aluminum-extrusion plant. Most building lumber is imported from the mainland. A number of garment manufacturers produce printed fabrics and apparel marketed locally, nationally, and abroad.

The Hawai„i film and movie industry is booming, with production expenditures expected to reach $391 million for 2010. The State provides competitive tax incentives, the only State-owned and operated film studio in the country and a growing list of production facilities, a well-established one-stop process for State film permits, and a film-friendly government and community. The DBEDT estimates that the amount of economic activity generated by the industry will total $606.5 million for

the year 2011. The jump in production expenditures is being driven by ten motion pictures as well as the final season of TV"s "Lost" and the start of two network shows, "Hawai„i Five-0" and "Off the Map". There have been a number of national and international commercials shot here, along with episodes for television series and a mini-series from Japan (DBEDT 2010).

Ocean-surface transportation is critical to Hawai„i, and Honolulu Harbor is the primary shipping center. A large percentage of the cargo ships traverse between Hawai„i and California ports, a few between Hawai„i and the East Coast of the United States via the Panama Canal, and others from western Pacific ports. Around-the-world passenger ships carry visitors through Honolulu, and there is an interisland luxury cruise line. Tug-pulled barges and small freighters transport goods from Honolulu to the outer islands, returning with agricultural crops and livestock.

A major concern is the high cost of living, due in large part to the dependence on imports. The State imports 85 percent of the food consumed in Hawai„i. Transportation costs are included in the prices of nearly all consumer goods. As the population increases, housing grows increasingly difficult to acquire, and it is disproportionately expensive when compared with housing costs in many of the mainland States. Building materials, most of which are imported, are expensive. Residential land is limited and highly priced, since much of the property is owned by corporations and trusts. More than half the land in the State is owned by private individuals or corporations, although the State itself, holding more than one-third of the land, is the largest single landowner. The Federal government owns one-sixth of the land in the State. State and county governments are major employers (Britannica 2010).

### 5.2.4 Refuge Contribution

The exact economic contribution of visitors to the James Campbell NWR has not been calculated, although estimations have been made for other refuges in Hawai„i. Carver and Caudill (2007) found that Hakalau Forest NWR had total annual recreational expenditures of $56,400 from 1,323 visitors. Similar to the James Campbell NWR, birding and other wildlife observations are the main attraction at the Hakalau Forest NWR. Based on this estimate, it is likely that the James Campbell NWR provides a similar contribution. Based on Fiscal Year 2011, the projected budget for the James Campbell NWR is $657,912, of which $415,401 is for employee salaries. The remaining $242,511 is for local expenditures.

In addition to recreational expenditures, the Refuge contributes money to the local economy through the Refuge Revenue Sharing Act of 1978 (16 U.S.C. 715s). This Act authorizes Federal payments to be transferred to the County of Honolulu annually in lieu of discontinued taxation of private property. The amount compensated is approximately 0.75 percent of the fair market value of fee lands. In 2009, $3,443 was paid to the City and County of Honolulu for 222 acres owned in fee title at James Campbell NWR. As we acquire more parcels within the approved boundary, these payments will increase accordingly, subject to congressional appropriations.

As public use facilities are developed, visitors to the north shore will be attracted to the Refuge and augment business revenue in Kahuku and local communities.

# Chapter 6. Environmental Effects Analysis

## 6.1 Overview of Effects Analysis

This effects analysis was developed by identifying resources associated with the physical, biological, and human environment identified in Chapters 3-5 of the Draft CCP/EA that may be impacted by the various alternative strategies presented in Chapter 2. The potential effects to those resources as a result of implementing the strategies described under each alternative were then assessed. This includes a brief discussion on potential impacts of climate change to Refuge resources.

The information used in this Draft CCP/EA was obtained from relevant scientific literature, existing databases and inventories, consultations with other professionals, professional knowledge of resources based on field visits, and personal experience. Subheadings have been included to guide the reader in understanding which types of management strategies are likely to affect each resource as not all management strategies affect each resource.

Cumulative impacts, including impacts to Refuge resources from reasonably foreseeable events and impacts resulting from interaction of Refuge actions with actions taking place outside the Refuge, are addressed in the final section of this chapter.

## 6.2 Terminology

Effects were assessed for scope, scale, and intensity of impacts to resources. Effects may be identified further as beneficial or negative, as well as long-term or short-term.

- **Negligible.** Resources would not be affected, or the effects would be at or near the lowest level of detection. Resource conditions would not change or would be so slight no measurable or perceptible consequence to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource would occur.

- **Minor.** Effects would be detectable but localized, small, and of little consequence to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource. Mitigation, if needed to offset adverse effects, would be easily implemented and successful.

- **Intermediate.** Effects would be readily detectable and localized, with measurable consequences to a population, wildlife, or plant community, recreation opportunity, visitor experience, or cultural resource. Mitigation measures would be needed to offset adverse effects and would be extensive, moderately complicated to implement, and probably successful.

- **Major.** Effects would be obvious and would result in substantial consequences to a population, wildlife, or plant community; recreation opportunity, visitor experience, or cultural resource within the local area and region. Extensive mitigating measures may be needed to offset adverse effects and would be large scale in nature, very complicated to

implement, and may not have a guaranteed probability of success. In some instances, major effects would include the irretrievable loss of the resource.

Time and duration of effects have been defined as follows.

- **Short-term.** An effect that generally would last less than a year or season.

- **Long-term.** A change in a resource or its condition that would last longer than a single year or season.

## 6.3 Summary of Management Action Effects at James Campbell NWR

A summary of the effects analysis is presented in Table 6-1. Current management (Alternative A) does benefit wildlife and habitats; however, effects are described in terms of the change from current conditions. Therefore, Alternative A generally has negligible, if any, effects because little or no change to management programs occurs under this alternative. Effects from Alternatives B and C are summarized in the table using the above definitions to describe the magnitude of change from the current condition.

**Table 6-1 CCP Alternatives Summary of Effects to the Refuge**

| | Alternative A | Alternative B | Alternative C |
|---|---|---|---|
| **EFFECTS TO SPECIES AND HABITAT** | | | |
| **Effects to endangered ae‘o, ‘alae ‘ula, and ‘alae ke‘oke‘o** | Negligible. No change from current management. Refuge continues to provide high-quality wetlands at current level supporting loafing, foraging, nesting, and chick rearing appropriate to life-history needs. | Minor long-term positive effect. Increased predator control efficiency through expanding predator control area should decrease predation on young and adult birds yielding a greater number of young fledged. Increased foraging and loafing area will become available as greater acreage is restored to suitable, high-quality wetlands thereby increasing the carrying capacity of the Refuge. | Intermediate long-term positive effect. Increased predator control efficiency through increased control activities on more acreage, particularly in areas of higher concentrations of this species, will result in decreased predation on young and adult birds yielding a greater number of young fledged. Increased frequency of water manipulation will result in increased production of suitable food throughout the year resulting in healthier birds and increasing the carrying capacity of the Refuge. Suitable, quality foraging and loafing areas will be maximized as wetland restoration expands potential habitat. |

| | Alternative A | Alternative B | Alternative C |
|---|---|---|---|
| **Effects to migratory waterbirds** | Negligible. No change from current management. | Greater water level manipulation, including pulsing water, will have minor short-term positive effects by stimulating production of invertebrates and seeds, thereby increasing foraging area and food abundance for shorebirds and waterfowl. Restored acreage of quality suitable wintering habitat will increase carrying capacity for migrant waterbirds. | Intermediate long-term positive benefits are expected. Acreage of suitable wintering waterbird habitat will be maximized with increased control of invasive plants coupled with water management. Increased predator control efficiency through increased control activities on more acreage will result in decreased predation. |
| **Effects to seabirds** | Negligible. No change from current management. | Minor long-term positive effect. Active vegetation management will increase suitable nesting habitat. Public use closures in previously unmanaged sensitive coastal dune nesting areas, pest plant removal, and predator controls should protect nesting seabirds and their chicks, increasing fledgling success and contribute to colony growth. | Intermediate long-term positive effect. Active vegetation management will increase suitable nesting habitat. Public use closures in previously unmanaged sensitive coastal dune nesting areas, pest plant removal, predator-proof fencing, and predator control should protect nesting seabirds and their chicks increasing fledgling success and contribute to colony growth. |
| **Effects to threatened honu** | Negligible. Not currently managed. | Minor long-term positive effect. Protection of sensitive dune nesting areas and predator control should protect nests, increasing hatching success and contributing to species recovery. | Minor long-term positive effect. Additional law enforcement, EE and interpretation, protection of sensitive dune nesting areas and predator control should protect nests, increasing hatching success and contributing to species recovery. |

| | Alternative A | Alternative B | Alternative C |
|---|---|---|---|
| **Effects to endangered ʻīlio-holo-i-ka-uaua** | Negligible. Not currently managed. | Minor long-term positive effect. Protection of sensitive dune pupping areas and terrestrial predator controls should contribute to species recovery and less disturbance. | Minor long-term positive effect. Additional law enforcement, EE, protection of sensitive dune pupping areas and terrestrial predator controls should contribute to species recovery and less disturbance. |
| **Effects to wetland habitats and associated resident wildlife** | Negligible. No change from current management. Quality habitat supporting endangered and other waterbirds will be managed and maintained at current levels. | Minor long-term positive benefits to resident wetland bird species due to reduction of waterbird predation within Refuge. An increase in wetland acreage will provide additional habitat. Pulsing water will have minor positive effect by stimulating germination of native plants, thereby increasing plant diversity and foraging habitat. | Intermediate long-term positive benefits to resident wetland bird species due to reduction in predation within Refuge over a greater area. Quality yearlong wetlands and associated habitat will result from increasing the acres to be managed. Maximized diversity of wetland types and plant communities will support larger populations of waterbirds. |
| **Effects to scrub/shrub habitat** | No effect. Not currently managed. | Minor long-term positive effect. Limited acreage will be restored. Native plants will be outplanted and the habitat will become more suitable for a variety of seabirds, including the mōlī. Wintering birds may also benefit. | Intermediate long-term positive effect. Maximum acreage will be restored under this alternative. Native plants will be outplanted and a greater effort made to control pest plants and maintain high-quality habitat. A greater area for seabird nesting will be provided, primarily for mōlī. Wintering birds may also benefit. Intermediate long-term positive effect on habitat restoration efforts with on-site greenhouse with increased ability to propagate native plants acclimated to the Refuge. |

| | Alternative A | Alternative B | Alternative C |
|---|---|---|---|
| **Effects to coastal strand/dune habitat** | Negligible. Currently, removal of marine debris from shoreline occurs once a year. Larger shrubs and trees are maintained to provide shade for potential ,,u,,au kani, Christmas shearwaters, and koa,,e,,ula underneath and higher nest sites for ,,ā. | Minor long-term positive effect. Marine debris removal will continue at the same rate. More active management of vegetation will occur, increasing suitable nesting habitat for potential ,,ua,,u kani, Christmas shearwaters, and koa,,e,,ula underneath and higher nest sites for ,,ā. Pest plant and predator control should protect nesting seabirds, honu, and ,,īlio-holo-i-ka-uaua. | Intermediate long-term positive effect. Marine debris removal will continue at the same rate. More active management of vegetation will occur, increasing suitable nesting habitat for potential ,,ua,,u kani, Christmas shearwaters, and koa,,e ,,ula underneath and higher nest sites for ,,ā. Pest plant and predator control should protect nesting seabirds, honu, and ,,īlio-holo-i-ka-uaua. Intermediate long-term positive effect on habitat restoration efforts with on-site greenhouse with increased ability to propagate native plants acclimated to the Refuge. |

*'Īlio-holo-i-ka-uaua rests on shore Dave Ellis/USFWS*

| | Alternative A | Alternative B | Alternative C |
|---|---|---|---|
| **PHYSICAL ENVIRONMENTAL EFFECTS** | | | |
| **Effects to air quality** | Negligible. No change from current management. | Short-term minor negative effects from a slight increase in infrequent prescribed fires and pile burning. Fence installation results in a short-term disturbance to air quality due to the use of heavy equipment to clear a path for the fence. | Short-term minor negative effects from a slight increase in infrequent prescribed fires and pile burning. Fence installation results in a short-term disturbance to air quality due to the use of heavy equipment to clear a path for the fence. |
| **Effects to water quality** | Negligible. No change from current management. | Minor long-term positive effects resulting from removal of woody vegetation, thereby favoring grasses and other more desirable vegetation supporting longer, more efficient water table recharge and reduction of silt-laden runoff to the nearshore environment. Increased frequency of water level manipulation will seasonally result in additional water being released to channels draining to the ocean. This is not expected to increase silt levels because of the low volume and slow release rates from wetland impoundments. Use of best management practices (BMPs) during construction projects will minimize effects on water quality during site preparation and ground disturbance portions of project. | Minor long-term positive effects resulting from removal of woody vegetation, thereby favoring grasses and other more desirable vegetation supporting longer more efficient water table recharge and reduction of silt-laden runoff to the nearshore environment. Increased frequency of water level manipulation will seasonally result in additional water being released to channels draining to the ocean. This is not expected to increase silt levels because of the low volume and slow release rates from wetland impoundments. Increased pulsing and water level manipulation is expected to increase water use by a minor amount on a yearly basis, remaining well within our permitted use. Use of BMPs during construction projects will minimize effects on water quality during site preparation and ground disturbance portions of project. |

| | Alternative A | Alternative B | Alternative C |
|---|---|---|---|
| **Effects to soils** | Negligible. No change from current management. | Minor long-term positive effect anticipated as water is again introduced to once hydric soils that have become more xeric as a result of altered surface and subsurface hydrology related to manmade channels and ditches. Fence installation results in a short-term disturbance to soil due to the use of heavy equipment to clear a path for the fence and then construction of the fence. | Intermediate long-term positive effect anticipated as expanded wetlands restoration is undertaken and water is reintroduced to larger areas of once hydric soils that have become more xeric as a result of altered surface and subsurface hydrology related to manmade channels and ditches. Fence installation results in a short-term disturbance to soil due to the use of heavy equipment to clear a path for the fence and then construction of the fence. |
| **SOCIAL EFFECTS** | | | |
| **Prospects for wildlife photograpy** | Negligible. No change from current management which allows for limited, seasonal opportunities in conjunction with public tours conducted 2 days a week on the Ki,,i Unit. | Minor long-term positive increase in opportunities and additional subjects associated with the coastal areas. The use in the Ki,,i Unit will be reduced as new viewing areas are developed in expansion lands. | Intermediate long-term positive increase in opportunities and additional subjects associated with the coastal areas. The use in the Ki,,i Unit will be reduced as new viewing areas are developed in expansion lands. |
| **Prospects for EE** | Negligible. No change from current management. The Refuge hosts EE groups on a seasonal basis from October 15-February 28. | Minor long-term positive effect. Additional resources may enable the Refuge to increase EE opportunities over a greater time period and accommodating increased number of students. | Intermediate long-term positive effect. More EE opportunities are expected resulting from additional resources and expanded areas suitable and compatible with Refuge operations. |
| **Prospects for interpreta-tion** | Negligible. No change from current management. | Minor long-term positive effect. Some additional opportunities developed with new visitor center and stepdown VSP. | Intermediate long-term positive effect. Additional opportunities developed with new visitor center and stepdown VSP. |

| | Alternative A | Alternative B | Alternative C |
|---|---|---|---|
| **FACILITIES** | | | |
| **Office and Visitor Center** | Negligible. No new Office and Visitor Center. | Intermediate long-term positive effect. Planning, design and construction of new office/visitor center, if funded. Short-term minor negative effects possible during construction phase work days due to increased construction traffic and activities, including increased noise. Use of BMPs during construction will minimize effects on water quality during site preparation and ground disturbance portions of project. | Intermediate long-term positive effect. Planning, design and construction, if funded. Short-term minor negative effects possible during construction phase work days due to increased construction traffic and construction activities, including increased noise. Use of BMPs during construction will minimize effects on water quality during site preparation and ground disturbance portions of project. |
| **Maintenance Facility, Bunkhouse, and Greenhouse** | Negligible. No new facilities constructed. Existing shop subject to negative environmental conditions and increased maintenance needs. | Negligible. No new maintenance facilities constructed. Existing shop subject to negative environmental conditions and increased maintenance needs. | Intermediate long-term positive effect. A new maintenance facility would reduce equipment maintenance and extend life of high-value heavy equipment, tractors, vehicles, etc. by providing protection from harsh coastal weather. A bunkhouse would provide onsite, affordable, temporary housing for volunteers, researchers, or interns thereby greatly enhancing their ability to work on the Refuge. Short-term minor negative effects possible during construction phase work days due to increased construction traffic and activities, including increased noise. Intermediate long-term positive effect with greenhouse to propagate native plants acclimated to the Refuge. BMPs during actual construction will minimize effects on water quality during site preparation and ground disturbance portions of project. |

| | | Alternative A | Alternative B | Alternative C |
|---|---|---|---|---|
| **EFFECTS TO NONNATIVE PREDATORS** | | | | |
| | **Fencing** | Negligible. Minor localized reduction in dogs and pigs. | Negligible. Minor localized reduction in dogs and pigs. | Negligible. Minor localized reduction in dogs and pigs. |
| CONTROL METHODS | **Live traps** | Negligible. Minor localized reduction of mongooses and cats. Nontarget species are released unharmed at capture site. | Minor localized reduction of mongooses, rats, mice, bullfrogs, pigs, dogs, and cats. Track tunnel monitoring may improve efficiency of live-trapping program. Nontarget species are released unharmed at capture site. | Minor localized reduction of mongooses, rats, mice, bullfrogs, pigs, dogs, and cats. Track tunnel monitoring may improve efficiency of live-trapping program. Nontarget species are released unharmed at capture site. Corral traps considered for pigs and dogs. |
| | **Bait stations** | Negligible. There have been no recorded incidents of nontarget species killed as a result of Refuge bait stations. | Minor long-term localized reduction of mongooses, rats, and mice. Track tunnel monitoring may improve efficiency of bait station program. | Minor long-term localized reduction of mongooses, rats, and mice over larger area. Track tunnel monitoring may improve efficiency of bait station program. |
| | **Predator-proof fence** | Not currently used. | Intermediate long-term positive effect with immediate exclusion of mongooses, dogs, cats, rats, and mice from specific highly sensitive areas. Potential to reduce the need for lethal predator control efforts. | Intermediate long-term positive effect with immediate exclusion of mongooses, dogs, cats, rats, and mice from specific highly sensitive areas. Potential to reduce the need for lethal predator control efforts. |
| | **Lethal traps** | Not currently used. | Potential for minor localized reduction of mongooses, cats, rats, and mice. Inadvertent nontarget species effects would be mitigated by trap design and program operation. | Potential for minor localized reduction of mongooses, cats, rats, and mice. Inadvertent nontarget species effects would be mitigated by trap design and program operation. |
| | **Shooting** | Negligible. Used intermittently for animals difficult to capture. It is a viable tool for individual predators that elude other control methods or pose an immediate danger to humans. | Negligible effects. Use of this tool may increase due to increased acreage and opportunity. | Negligible effects. Use of this tool may increase due to increased acreage and opportunity. |

# 6.4 Effects Analysis

The following analysis describes the anticipated effects of implementing the Refuge management strategies described in Chapter 2 on the physical, biological, and social environment, the attributes of which were described in detail in Chapters 3, 4, and 5.

## 6.4.1 Effects of Management Actions to Protect Endangered Waterbirds

### 6.4.1.1 Fencing

Currently a combination of barbed wire and hog wire fence is used both internally and along the perimeter of the Refuge as a deterrent to minimize mammalian predator and unauthorized human access to the Refuge. Round wooden 4-inch diameter posts are used because of their ability to withstand the harsh coastal environment. Woven hog-wire (47-inch high) is made of weather-resistant material (Benonal). Although this material is relatively expensive, it provides long fence life and reduced maintenance. Two to three strands of barbed wire are strung above the top of the hog-wire and both fencing materials are stapled to the wooden posts. The hog-wire is a series of rectangles woven into a single roll of fencing. Chain-link fence topped with strands of barbed wire is considered a viable preventive aid to deter predators and human trespass, but is currently not used because of the harsh, corrosive coastal environment. There is also the need to ensure that ʻōpeʻapeʻa do not become entangled in barbed wire they cannot detect through echolocation. Small mammals such as mice, rats, and mongooses can move through most types of fence. Cats (and potentially dogs) can climb over some fences. Monitoring of fences for breaches (such as cuts made by humans; digging by animals; and damage from falling trees and limbs) is ongoing and time consuming.

*Pigs follow the Kiʻi Unit fence George Fisher/USFWS*

Trial use of predator-proof fences is recommended to protect highly sensitive sites on the Refuge, such as nesting and chick-rearing sites and sensitive, threatened, or endangered plant populations. These fences are very expensive, but have been proven to prevent entry by mammals as small as a mouse. They are designed to prevent digging under and climbing over by animals. They are not failproof because damage from human vandalism and natural causes, such as falling trees and branches, can result in failure. Predator-proof fences have been successfully used on a large scale in New Zealand. A current project to install the first predator-proof fence on the northwest tip of Oʻahu has been initiated for the Kaʻena Point Natural Area Reserve for protection of coastal resources. This project should provide valuable information and experience that can be used in development of a similar fence on the Refuge.

Fence installation results in a short-term disturbance to vegetation, soil, air quality, and noise level due to the use of heavy equipment to clear a path for the fence, construction of the fence, and cyclical replacement. These effects are negligible and short-term compared to the benefits gained over the long-term by protecting habitats and native wildlife dependent on them, especially endangered

species. Predator-proof fencing should reduce the need for lethal control methods and decrease use of other techniques in the long-term. This would also result in long-term financial savings. Predator-proof fencing might not be appropriate for all areas of the Refuge because of topographical features, waterways, and access points.

Implementation of either Alternative B or C will have negligible impacts. These fences can only keep dogs and pigs out of enclosed areas. Standard hog/barbed-wire fences do not prevent access by smaller predators such as cats, mongooses, and rats.

### 6.4.1.2 Live trapping

Currently, Tomahawk® walk-in live traps are used, but other similar devices could be considered for use in the future, if deemed appropriate for target species. Traps are set and baited with dry pet food, canned foods, and sardines. Sometimes used cooking oils are used to create a different olfactory attractant in an attempt to capture trap-wary animals that might be avoiding certain baits. Trying different baits and rotating through various baits is a part of the program. Walk-in traps are checked daily when set. If traps cannot be checked at this frequency, they are closed. Under ESA Section 7 compliance documents, the Refuge is required to check the traps at least once every 48 hours.

A cover over each Tomahawk® trap provides shade along with an attached water bottle that allows a trapped animal to drink. When a target species is captured, it is euthanized by shooting with a small caliber weapon, generally a .22 caliber rifle or pistol. Carcasses are disposed of according to State and local requirements at an approved location.

Nontarget species are occasionally caught in this type of trap. A small number are occasionally found dead, mostly the result of predation by mammalian predators attacking from outside the trap. These nontarget animals are primarily nonnative doves and cardinals that are released unharmed at the capture site. Effects to nontarget species are negligible because they are nonnative and widespread on O,,ahu. The area of effect (Refuge) is infinitesimal compared to the range and numbers of nontargets affected. Effects to target species are also negligible because they are widespread on O,,ahu and the area of effect is insignificant compared to the range and numbers of target species.

Cage traps, including both large corral traps and portable drop-gate traps, are the most popular and effective trap methods for capturing pigs and dogs, but success varies seasonally with the availability of natural food sources. Cage or pen traps are based on a holding container with some type of a gate or door. In this situation, animals are lured either by a pathway and/or bait into an enclosure with a one-way entry point. Captured pigs would be euthanized on site using a small caliber weapon and disposed of according to applicable regulations. Captured dogs are usually turned over to the Hawaiian Humane Society. This type of trap allows release of nontarget species that may inadvertently be drawn into it. There are many variations in design for these traps and specific designs will be selected based on applicability on specific areas and conditions on the Refuge. An advantage of these designs is that many are constructed from readily available materials (woven wire, steel/wooden fence posts milled lumber). They are also relatively easy to assemble, disassemble, and transport for set-up at different locations. Control or eradication of pigs from the Refuge will positively affect the recovery of endangered waterbirds and enhance restoration activities aimed at reducing pest plants and animals and outplanting and/or fostering native plants. Removing pigs from the Refuge is also anticipated to have a positive effect on surrounding lands by reducing potential for damage at nearby golf courses and agricultural properties (Barrett & Birmingham 1994, Mapston 1999).

Specialized cylindrical wire traps that look much like minnow traps are placed in wetland impoundments seasonally to capture bullfrogs. Placement is guided by location of ae„o nests. Traps are typically placed in March and maintained into July, the period when ae„o chicks hatch. Traps are moved as needed to maximize bullfrog reduction in areas where active nesting and chick rearing occurs. Other animals caught in these traps include *Tilapia*, apple snails, Pacific giant toads, and crayfish. These nonnative animals may be killed or released. Captured bullfrogs are killed and disposed of in accordance with applicable regulations. Prior to disposal, most carcasses are necropsied to gather information that adds to our knowledge of this species on the Refuge.

Reduction of the bullfrog population has resulted in increased ae„o chick survival on the Refuge, helping fulfill one of the Refuge purposes. Control is in a limited area compared to the distribution of bullfrogs on O„ahu and throughout the main Hawaiian Islands. The effect on the overall population of this species is anticipated to be negligible. Although crayfish are not native to Hawai„i, they are an important food to endangered and migratory waterbirds, so reduction of bullfrogs maintains an ample food supply for these species.

Implementation of either Alternative B or C will result in a minor localized reduction of mongooses, rats, mice, bullfrogs, pigs, dogs, and cats. Track tunnel monitoring may improve efficiency of live-trapping program.

#### 6.4.1.3 Lethal Trapping

Currently, no lethal traps are being deployed on the Refuge. Under Alternatives B and C, however, this type of trap may be considered to protect endangered species and meet Refuge goals and objectives for management and recovery. Several designs are available that are intended to instantly dispatch animals in a humane manner. A design that has been explored in Hawai„i is the New Zealand Department of Conservation (DOC) series of lethal traps. The kill portion of the trap is enclosed in a sturdy box for safety and the entrance to the trap is designed to keep out nontarget species. These traps are intended for capturing and humanely killing small mammals up to the size of cats. Traps in the DOC series have passed stringent New Zealand National Animal Welfare Advisory Committee standards as a humane kill trap.

We anticipate the implementation of lethal traps will further reduce the number of predators that prey on or otherwise impact endangered species recovery. Traps will be selected to capture the appropriate size animals at specific locations and will allow the targeting of difficult-to-capture individuals that might have developed “capture device” aversion to other capture mechanisms and techniques. Trap size and design will be selected to target predator species that are or have been implicated in taking native wildlife, particularly endangered and threatened species, and minimize the opportunity to capture nontarget species. When lethal traps are deployed, authorized entry points to the area of usage will be signed to alert the public that such devices are in use. Traps will be checked at least every 3 days to remove any captured animals and dispose of them according to applicable regulations.

Implementation of either Alternative B or C will result in a minor localized reduction of mongooses, rats, mice, bullfrogs, pigs, dogs, and cats. Track tunnel monitoring may improve efficiency of live-trapping program.

### 6.4.1.4 Bait Stations

Diphacinone bait blocks are used in approved lockable bait boxes. Commonly used throughout the State, the size and design of these bait stations allows entry to animals up to the size of a mongoose. This includes mice and rats. Each bait station is labeled with a contact number and each Refuge entry area is signed with a warning notifying the public that bait stations are in use in the area. Bait is secured in each bait box according to regulations. Bait is checked once weekly, with new blocks placed in the box to replace eaten ones, and the data recorded. Small portions of blocks left in the bait box are disposed of according to label requirements. The diphacinone bait blocks are not water soluble, are secured within the weather-resistant bait station, and do not leach into surrounding water and soil.

Exact numbers of target species affected by bait stations are difficult to ascertain from direct observations because target species are relatively small and head to cover after consuming bait. Very few animals are found after they consume the diphacinone bait. Presently, observation of target animals on the Refuge is the only method used to determine relative presence. Under Alternatives B and C, implementation of track tunnel monitoring will occur on a quarterly basis. Use of track tunnels devices will provide a more accurate numerical and trend assessment of mice, rats, and mongooses on the Refuge. The devices allow identification of tracks left by species that walk through a nontoxic ink. Track tunnel monitoring will help us determine the efficacy of ongoing predator control programs; target only pest species present/active in a particular area; and provide information needed to make modifications to improve the program using relative abundance information for targeted species.

Presently, the use of track tunnels is intermittent. Under Alternatives B and C, implementation of a yearlong monitoring program is anticipated. Each cycle of monitoring encompasses a 4-day period. Under these alternatives, one tract tunnel monitoring cycle will be conducted quarterly during the year, initially. Refining of the number of monitoring efforts necessary to provide an appropriate level of data will be undertaken and this quarterly monitoring schedule may be revised, if appropriate.

Bait stations are currently used on only a portion of the Refuge (Ki„i Unit). Since use of bait stations provides a safe and approved method of controlling rodents and mongooses in Hawai„i, they are considered for use on other areas of the Refuge under Alternative B with expanded use under Alternative C to reduce and maintain minimal small mammal predator numbers to protect native and endangered species of animals and plants. Under Alternatives B and C, additional acreage will be actively managed and restored to a more functional environmental community, supporting greater numbers and diversity of native plants and animals. To provide the optimal possible habitat supporting the greatest carrying capacity, predators will need to be controlled on areas not presently having a predator management program. The expansion to other parts of the Refuge will support endangered species recovery efforts by increasing nesting success and survival of young to fledgling age to be recruited into the population and contributing toward high quality habitat. Native plants are expected to benefit through increased seed survival and lower seedling predation by rodents, contributing to a more rapid recovery of restored native plant communities on the Refuge. Abundant native plant seed production would allow seeds to be banked for future outplanting on the Refuge or other locations within the plant‟s historic range where it might have been extirpated.

The number of predators affected is anticipated to be negligible compared with the overall populations on O„ahu. Predators targeted by bait stations (mice, rats, and mongooses) have large, widespread populations throughout the main Hawaiian Islands and are known to be highly

reproductive. The result of using bait stations will be a reduction in target species in sensitive resource management areas for endangered and other native species. A positive intermediate effect is anticipated with fewer predators impinging on native animals and plants.

Bait station design prevents entry of most nontarget species (for this control method) such as pigs, cats, and dogs. Introduced land snails, geckos, and Pacific giant toads have been observed in the stations, but there have been no incidents of death caused to these species. Implementation of either Alternative B or C will result in a minor long-term reduction of mongooses, rats, mice, bullfrogs, pigs, dogs, and cats. Track tunnel monitoring may improve efficiency of live-trapping program.

#### 6.4.1.5 Shooting

Shooting with small–caliber rim fire and center fire firearms and shotguns by trained and qualified individuals is a viable tool for controlling difficult to trap individual animals or removal of predator species on an opportunistic basis. This tool is very selective and specific predators can be targeted for removal. Sound-suppressed firearms will be used when possible to minimize any disturbance to nearby neighbors. Dispatched animals will be removed from the site so as not to impact human health or adversely impact other wildlife. Predator control activities are confined to the Refuge, encompassing a maximum of 1,100 acres. Impacts to the islandwide predator population are considered negligible because of the high number, extensive range, and wide distribution of pigs, mongooses, mice, rats, bullfrogs, and cats occurring in the wild on O,,ahu.

Cattle egrets have been documented taking chicks of all endangered waterbirds species occurring on the Refuge and may be taken under a permit from the Service"s Office of Migratory Birds. This species may be taken using either .22 caliber weapons or shotguns with slugs or nontoxic shot material. Limited numbers of this species are expected to be removed from the Refuge for the protection and recovery of endangered waterbirds. Compared to the large population and distribution of this species on O,,ahu and throughout Hawai,,i, the number anticipated to be removed will be minor and will not have an effect on birds outside the local geographic area. Intermediate positive benefits to endangered waterbird recovery are anticipated resulting from decreased chick predation and birds recruited into the population. Increased fledgling success will contribute to the overall population of each species on O,,ahu and other islands as young birds disperse from the Refuge, thereby positively affecting recovery (Elepaio Vol. 46).

The effects of reducing or eliminating predation by utilizing one or more of the above techniques provide intermediate positive benefits to endangered, other resident, and migratory waterbirds, as well as endangered ,,īlio-holo-i-ka-uaua and threatened honu. For endangered species, increased survival of young will move each species closer to the potential for recovery and delisting.

Implementation of either Alternative B or C will result in negligible impacts as it is only used intermittently for animals difficult to capture. It is a viable tool for individual predators that elude other control methods or pose an immediate danger to humans.

### 6.4.2 Effects of Management Actions to Intensively Manage Wetland Habitat

#### 6.4.2.1 Water level manipulation

This management tool incorporates incremental raising and lowering of water levels (referred to as "pulsing") coupled with the duration and seasonal timing of water held on a particular wetland

impoundment. The water level, timing, duration, and degree of pulsing affects plant germination and growth, invertebrate production, and food accessibility to foraging shorebirds and endangered waterbird chicks. Alteration of successional stages of wetland vegetation is also achieved using this tool. A variety of successional stages occurring simultaneously in wetlands contributes to increased wildlife and plant diversity. It also contributes to wetland conditions supporting a greater number of species and life-history needs of endangered and migrant waterbirds using the Refuge. Prolonged drying aids soil rejuvenation by oxygenating soil and reducing the number of fish, such as *Tilapia*, that compete with waterbirds for invertebrates. After such a treatment, a more aerobic wetland condition exists when water is reapplied to wetland impoundments.

Pulsing just prior to chick hatching stimulates increased production of invertebrates consumed by the endangered waterbirds. This assists managers in providing ample food to help maximize fledglings and increase populations. Invertebrates range from small insects the size of midges to macroinvertebrates like crayfish. All are important food items for various life stages of Hawai„i"s endangered waterbirds. Pulsing also creates suitable substrate, moisture, and temperature conditions to favor wetland plant germination. Many wetland plants provide food, cover, and/or nesting habitat/structure.

Water level management is one of the primary endangered species management tools used on the Refuge. The frequency of pulsing is currently limited due to staffing shortage and workload. Under Alternative B, pulsing will be increased to enhance habitat and moderately improve endangered waterbird recovery potential on the Refuge. Under Alternative C, use of this tool will be increased to gain optimal benefits for enhancing habitat, increasing production, and rearing of young waterbirds.

The effects of increased pulsing include potential increases in fledged waterbird chicks and additional suitable nesting and maintenance habitat. Throughout the summer, there is an increased risk of botulism. Maintaining a flow of water through water control structures helps keep water temperatures lower by circulating cooler ground water. Cooler water temperatures and higher oxygen levels reduce the potential for botulism outbreaks. This flow of water results in a moderate increase in water consumption seasonally. To offset this use, water usage is continually monitored and when rainfall levels permit, groundwater is reduced. This water-saving measure is utilized throughout the year.

Vegetation can be controlled by rapidly raising water levels and holding several inches of water over the top of plants that are forming a monotypic stand or are undesirable in a particular wetland. This technique does not work on all plant species and is used only when it does not negatively affect endangered species. During the cooler fall and winter months, it is often not necessary to provide a continual flow of water through wetland impoundments. During this period, evapotranspiration (combination of environmental evaporation and plant transpiration) can be used to assist pulsing and maintaining desired water levels.

The positive effects for endangered, resident, and migratory water-related species occur because the pulsing provides a sustainable food base, encourages invertebrate hatches which leads to increase food supply throughout the year for young and adult birds. Wetland plants require variable soil moisture, temperature, ambient temperature, and duration of wetting for successful germination of a variety of native plants beneficial to a host of vertebrate and invertebrate species found in the wetland community. The successful seed production resulting from pulsing and maintaining a healthy and diverse assemblage of wetland plants ensures future plant presence into the future.

Although they are not native, crayfish are an important food source to waterbirds especially during chick rearing periods. The migratory kioea also regularly feeds on this macroinvertebrate which is a source of protein and calcium. Since manipulating water levels is staggered among wetland impoundments, there is some habitat for a greater variety of water-dependent birds throughout the Refuge. This minimizes the potential for creating a system where all water is either too deep or too shallow for accommodating the life history needs of waterbirds seasonally and throughout the year. Lower levels also produce a protected environment for waterbirds to roost during the night with reduced chance of predators sneaking up on them. The periods of drying or lowering water levels where a moist mud substrate exists may actually assist in controlling bullfrogs, a known predator on endangered ae,,o chicks, by drying areas where egg masses are attached resulting in their inability to hatch.

Implementation of Alternative B will result in a minor long-term positive effect. Increased predator control efficiency through expanding predator control area should decrease predation on young and adult birds yielding a greater number of young fledged. Increased foraging and loafing area will become available as greater acreage is restored to suitable, high-quality wetlands thereby increasing the carrying capacity of the Refuge.

Implementation of Alternative C will result in an intermediate long-term positive effect. Increased predator control efficiency through increased control activities on more acreage, particularly in areas of higher concentrations of this species, will result in decreased predation on young and adult birds yielding a greater number of young fledged. Increased frequency of water manipulation will result in increased production of suitable food throughout the year resulting in healthier birds and increasing the carrying capacity of the Refuge. Suitable, quality foraging and loafing areas will be maximized as wetland restoration expands potential habitat.

#### 6.4.2.2 Mechanical Treatment

Mowing and tilling are currently used to maintain and improve habitat. These tools are used both on uplands, within seasonal wetlands, and within intensively managed wetlands to control vegetation height, composition, and interspersion. Manipulation of these vegetative components for resource management purposes positively affects wildlife and the overall landscape. Waterbirds utilize a variety of vegetative conditions. Endangered ,alae ke,,oke,,o and ,alae ,,ula feed on dikes and within wetlands where short grass and other plants (<4 in. tall) occur. Younger plants have less cellulose, more digestible nutrients, and are preferentially selected over older plants. This habitat condition is also utilized by ae,,o and a variety of other waterbirds for loafing and foraging. Overgrown areas provide concealment cover for predators that prey on waterbirds and their young. Mechanical treatment is used as a follow-up to prescribed burning to complete some habitat enhancement projects on the Refuge. Tractors or other appropriate equipment pull the implements used to accomplish the mowing, and tilling. These tools will continue to be utilized under all alternatives with greater frequency, and over larger areas as active management expands under Alternatives B and C.

When vegetation control is required in areas where water drawdowns are not attainable, feasible, or desirable, a floating aquatic weedcutter (a small gasoline-powered boat with an attached sickle-bar cutter on the front) is used. This equipment can operate in water up to 2-feet deep and cut vegetation at different depths depending on the outcome desired. Once cut, vegetation is either left to decompose in place or removed from the water and allowed to decompose on adjacent uplands. The aquatic weedcutter can be used to create desirable mosaics of open water to vegetation, which can

increase carrying capacity. Creating physical and visual barriers and interspersion increases territories that can be occupied by waterbirds.

Disking has a potential to be used to break up accumulation of organic matter; destroy root systems of undesirable plants; and loosen soil for improved aeration. Controlled use of this tool is considered appropriate for improving habitat conditions. Shallow (1-6 in.) disking will be considered and used appropriately on areas where soil and soil moisture conditions warrant.

Use of mechanical techniques entails the use of motorized equipment and therefore contributes to the greenhouse effect. To minimize the carbon foot print contributed by mechanical control, the Refuge will use these techniques with the most fuel-efficient equipment feasible. Under the preferred Alternative C, it is anticipated no more than five pieces of equipment will operate at the same time. This constitutes a negligible burden on the environment compared to the number of fuel-burning vehicles operating in the local area and on the Island of O„ahu. This effect will be far outweighed by the moderate positive effects to the natural landscape and natural resources, including recovery of endangered waterbirds.

Implementation of Alternative B or C will result in minor long-term positive effects to water quality resulting from removal of woody vegetation, thereby favoring grasses and other more desirable vegetation supporting longer, more efficient water table recharge and reduction of silt-laden runoff to the nearshore environment.

### 6.4.2.3 Chemical Treatment

Chemical treatment is another tool used to control vegetation. The presence of many perennial plant species, many of which are managed as part of a habitat management scheme, necessitates the use of herbicides. Only EPA-approved herbicides for wetlands are applied in and around water areas under the guidance of trained applicator(s). We strive to minimize the use of herbicides and apply them in compliance with label requirements, agency policy, Section 7 requirements of the ESA and other applicable regulations. The concentration used is only as high as necessary to control the targeted species. It is anticipated that Rodeo® (or other appropriate glyphosate-based herbicides) and Habitat® will be the preferred and most-used herbicides in and adjacent to wetlands. These are both approved for use in wetlands. Adjuvant is added during application to maximize the effect of the herbicide on target species. Only appropriate adjuvant that is compatible with the herbicide is used. Additionally, a nontoxic color dye is used to visually detect the area where application has occurred. This helps achieve complete coverage of the treatment area and minimizes the quantity of herbicide used by reducing the potential for multiple spraying of the same area. Whenever possible, wetland impoundments are dewatered prior to the application of herbicides. Herbicide is not applied when wind conditions could carry it to an area where control is not intended.

Other herbicides designed for controlling woody vegetation will likely be necessary during upland restoration projects. Many woody shrubs and trees have the ability to resprout after mechanical treatment, such as cutting. A technique of cutting followed almost immediately with herbicide application on the cut is required to prevent resprouting and repetitive treatment. Herbicides successfully used on this type of vegetation in Hawai„i include Garlon 3A® and Garlon 4®. The same precautions will be followed when using these or other herbicides. This type of treatment is a “spot” treatment as herbicide is applied to an individual plant and not broadcast over an area covered with plants. This minimizes the area affected and reduces the quantity of chemical used.

Under all alternatives, negligible short-term negative effects to nontarget plant species will be mitigated by training personnel to identify and avoid treatment of nontarget species. Negligible short-term negative effects to nonnative birds may result from the reduction in nesting habitat. These effects are far off-set by the widespread distribution and large populations of species such as red-vented bulbul and myna birds. We will use herbicides to augment other vegetation control techniques like water level manipulation, mechanical treatment, and prescribed fire. Application is overseen by a certified pesticide applicator, further reducing the potential for undesirable effects. In relation to pesticides used throughout the local area as part of agricultural and aquaculture operations, the quantity proposed for use on the Refuge for habitat management is anticipated to be negligible.

#### 6.4.2.4 Fire

The suppression of wildfires and the use of prescribed or controlled fire are a long-standing part of resource protection, public safety, and habitat management on national wildlife refuges. In 2003, a Fire Management Plan that incorporated NEPA compliance was approved for the Refuge and provides detailed guidance for the suppression and use of prescribed fire. The plan outlines wildfire response and prescribed fire objectives, strategies, responsibilities, equipment and staffing; burn units; implementation; monitoring; and evaluation. The complete Fire Management Plan is available at the Complex office (USFWS 2003).

Conducted under an Agricultural Burn Permit issued by the State Department of Health, Clean Air Branch, prescribed burning is used primarily to improve habitat and control undesirable vegetation on the Refuge. Burning removes aggressive pest species such as California grass without retention of large amounts of vegetated material (left during mechanical treatments) which can lead to botulism potential and decreased water quality. Decreased water quality occurs when biodegradation of plant material diminishes dissolved oxygen.

Desirable wetland plants are stimulated by reducing competition with pest plants. The fire regime used (slow backing to flanking) produces moderate temperatures that do not adversely affect soils. Burning more rapidly returns nutrients tied up in undesirable pest vegetation back to the soil to be used by more beneficial species. Following burns, surveys have documented increased species diversity and numbers of both endangered and other water-dependent birds. Prior to expansion of the Refuge, approximately 8-15 ac of habitat was enhanced using prescribed fire annually. We expect to increase the acreage in the prescribed burn program with Refuge expansion to improve and maintain habitat quality on a larger scale. In addition, in the future, prescribed burning of piled brush could occur to reduce hazardous fuels along the northern and southern edge of the Refuge.

The typical prescribed burning season to improve wetland habitat on the Refuge extends from approximately the beginning of September-October. Prescribed burns on the Refuge have been conducted for more than 10 years. Annually, about 10 acres are burned on the Ki„i Unit. The prescribed burning cycle varies from 2-3 years in a given impoundment. Prescribed burning on uplands on Refuge expansion lands could allow a larger burn window. As is currently done, all applicable local, State, and Federal regulations regarding the use of fire will be adhered to during burn operations.

Other agricultural burning occurs in the local area and the infrequent burning conducted by the Refuge under all alternatives is anticipated to negatively affect air quality at a minor level on a short-term basis.

### 6.4.2.5 Ditch maintenance/cleaning

This activity consists of removing vegetation from along ditch banks and within the ditches flowing through the Refuge. The major ditches involved in this process are Hospital, Ki„i, Punamanō (East-West), and Outlet Ditches. Sand plug removal is also required periodically in the Outlet Ditch to maintain a water flow to the ocean. These ditches essentially drain that portion of the Ko,„olau Mountain Range from Kahuku Point to the Town of Kahuku. This drainage system is manmade and was once associated with sugar cane production in the area.

Rental or Service-owned equipment will be used to accomplish the cleaning, which will be done periodically on an as needed basis to reduce vegetation that might interfere with water flow to the ocean. Cleaning is anticipated to be accomplished on a rotational basis with not all ditches being cleaned in a single event or project. Vegetation growth rates related to weather, water salinity, and possibly other environmental factors will affect the cleaning frequency.

Material removed during the project will be placed on top of the dike and left to biodegrade. Material removed during cleaning events will not be placed or disposed of in wetlands. Outlet Ditch cleaning is required to remove sand deposited associated with shoreline currents. The sand buildup impedes water flow to the ocean. Sand will be removed using heavy equipment such as tracked vehicles (small dozer, skidloader, etc.), backhoes, and other appropriate equipment. Sand that is removed will be redeposited onto the existing sand dunes, coastal strand, and ditch banks. These locations are essentially the origins of the sand as it is eroded and transported along the shoreline. Ditch clearing will be done with the necessary concurrence and/or permits from USACE.

Under all alternatives, minor effects on the natural environment are anticipated with these activities. Low levels of turbidity can be expected during the actual vegetation removal process as vegetation is pulled from the ditch(s). The normally low flow rate of the ditches is expected to allow most loosened sediment to settle out in the ditch before water exits into the ocean. There are also mechanical devices such as one-way duck-bill check valves that also will assist settling of sediment. Since the majority of material removed and deposited on the ditch bank will be vegetative (little sediment will be redistributed) and this organic matter will decompose, it is not anticipated that more than a minor short-term height in the ditch bank will result. The height will be naturally decreased as decomposition occurs. This removal is expected to have a positive effect on allowing water to more freely flow and reduce, to some degree, potential impacts from flooding at the Town of Kahuku. The minor to moderate positive effects of the cleaning are not anticipated to negate flooding associated with major flood events.

Minimizing vegetative decomposition in the water of the ditches and maintaining a flow that contributes to oxygenation of the ditch water will to a minor to moderate level reduce the potential for a form of botulism that can be deadly to water-related birds since this bacterium needs an anaerobic environment to thrive. Reducing endangered waterbird mortality from this disease will further add to recovery of these imperiled species.

During the work there will be a minor short-term increase in noise and carbon footprint associated with the use of heavy equipment compared to normal Refuge operations when this event is not occurring. To offset minor noise impacts, cleaning will only occur during daylight hours. Compared with regularly occurring agricultural and maintenance activities occurring in the local area and other locations on the Island of O,„ahu, this action is anticipated to have a negligible to minor cumulative impact to the environment.

### 6.4.3 Effects of Management Actions to Restore Remnant Wetland Habitat

Major alteration of the landscape is not required to restore remnant wetlands capable of supporting waterbirds because in most areas soils and hydrology are still functioning in a relatively natural manner. Selected sites will be investigated for the feasibility of installing small water control structures to partially restore water level management in remnant wetlands. This limited management capability may improve the ability to control pest species and increase habitat diversity but overall management would remain less intensive under this objective as compared with the intensively managed wetlands on the Ki„i Unit. We expect long-term minor positive impacts to endangered waterbirds by restoring additional wetland acreage for loafing, foraging, and nesting.

Aquaculture ponds are currently under lease with the Service for shrimp and prawn farming on 137 acres of the Refuge. These leases are scheduled to expire in 2023, when they will revert to Refuge management. Lessees may relinquish their leases prior to 2023 on a voluntary basis, or if they fail to meet the conditions of the leases. Under current aquaculture operations, some of the ponds may be idle at times. This provides an opportunity for voluntary cooperative management strategies between the lessees and the Refuge to provide additional wetland habitat through water level management (raising and/or lowering water level). When ponds permanently revert to Refuge management, they will be assessed for reconfiguration, size modification, potential for providing a more diverse wetland type mosaic, and more active management strategies. A Comprehensive Water Resources Study is planned to initiate in 2018 to prepare for the transfer.

Implementation of Alternative B will have negligible affects. There is expected to be a moderate affect under Alternative C resulting from modifying and intensifying management on these 137 acres, which will expand and enhance endangered species recovery potential on the Refuge and allow for production and support of a greater number of endangered waterbirds. Larger numbers of migratory species, including waterfowl and shorebirds, should also be supported, which is important since Hawai„i is the major wintering area for some of these species. The kioea and kōlea are examples. Some of these species are exhibiting declining populations and providing protection and quality habitat (providing loafing, roosting, and foraging areas with ample food) for them is crucial to supporting their long flight back to Arctic breeding grounds.

The lease expiration is anticipated to have a minor to moderate effect on aquaculture operators since existing leases will end in 2023 and full implementation of habitat improvement will not occur until near the end of the anticipated life of this CCP. At the time the leases expire, lessees will be relocated at government expense to equivalent land where they can continue their operations, if they choose.

### 6.4.4 Effects of Management Actions to Restore Scrub/Shrub Habitat

Abandoned aquaculture facilities would be cleaned up for an intermediate long-term positive effect allowing for restoration of the natural ecosystem. Native plants will be outplanted and a greater effort made to control pest plants and maintain high-quality habitat. A greater area for seabird nesting will be provided, primarily for mōlī. Wintering birds may also have positive benefits with additional cover and foraging areas.

The Refuge plans to work with partners to restore a viable natural native plant community through removal of pest plants and outplanting of native plants that were part of the historic vegetative community. Plans to construct a greenhouse in objective 2.2 will enhance the Refuge‟s ability to

promote native plant propagation for use on the Refuge. If feasible, establishing new populations of the endangered ʻEwa hinahina and ʻakoko plants will have long-term positive effects on species recovery.

Implementation of Alternative B will result in a minor long-term positive effect. Limited acreage will be restored. Native plants will be outplanted and the habitat will become more suitable for a variety of seabirds, including the mōlī.

Implementation of Alternative C will result in an intermediate long-term positive effect. Maximum acreage will be restored under this alternative. Native plants will be outplanted and a greater effort made to control pest plants and maintain high-quality habitat. A greater area for seabird nesting will be provided, primarily for mōlī. Wintering birds may also benefit. Intermediate long-term positive effect on habitat restoration efforts with on-site greenhouse with increased ability to propagate native plants acclimated to the Refuge.

## 6.4.5 Effects of Management Actions on Coastal Strand/Dune Habitat

Low intensity management on beach and dunes will include fencing, spot treatment of pest plants, and minimizing predator disturbances. Semi-annual beach clean-ups will be coordinated with volunteers. Removing marine debris from the coastal zone is an important step to prevent entanglement and ingestion by honu, marine mammals, and migratory birds.

Seabird management on James Campbell NWR is associated with the expansion, since the James Campbell National Wildlife Refuge Expansion Act of 2005 specifically lists these and other species to become management priorities for which the expansion was approved by Congress. The information covering seabirds is based on field reconnaissance and literature reviews. Six seabird species are believed to be potential initial nesters in this habitat when it is actively managed. These species in order of feasibility of attraction are mōlī, ʻuaʻu kani, koaʻe ʻula, ʻāʻā, kaʻupu, and Christmas shearwater. Presently the first two species listed are known to occur in the immediate area. After colonization by these species, other species found in Hawaiʻi could be more attracted and possibly nest.

Recent failed nesting attempts have been noted in the area (mōlī, ʻuaʻu kani). Anecdotal reports suggest that on rare occasion seabirds have fledged in the area. Predation by dogs has been documented on several occasions and has been noteworthy enough to make the incident newsworthy. Adults and nests are susceptible to mammalian predation by dogs, pigs, rats, cats, and small Indian mongooses. Rats and other rodents are known to result in failed seabird nesting in the NWHI, although rats have now been removed from all of the NWHI. Control of these predators on the Refuge will be necessary to effectively establish and maintain successful nesting seabird colony(s).

Mōlī have attempted to breed at Kahuku Point since 1979 but were unsuccessful in establishing and maintaining colonies due to chick predation by dogs and crushing of nests by ORVs. The site was abandoned in 1996 but is still regularly visited (Young, et al. 2009).

ʻUaʻu kani breed commonly on Oʻahu and the largest colonies, apart from Lehua Island, are found on the offshore islets. With protection from mammalian predators, a thriving colony occurs at Kaʻena Point. Smaller colonies, with no protection from predators, occur at Black Point, Mōkapu Peninsula, Kahuku, and Mālaekahana (Pyle and Pyle 2009).

Removal of woody pest plants to maintain breeze flow is critical to aid in thermoregulation of nesting adults and prefledgling birds. During periods of high temperatures, seabirds depend on airflow to help maintain normal body temperature. Parents have to remain on the nest during incubation, making departure from the area infeasible because mortality of the developing embryo could occur. Fostering desirable vegetation capable of support nesting habitat for the aforementioned species will be beneficial to establishment of a seabird nesting colony on the Refuge. Effects are anticipated to be minor to moderate in Alternatives B and C.

## 6.4.6 Effects of Promoting Management-related Research and Scientific Assessments

Being able to compare Refuge data with other local, regional, and even global data will help guide ecosystem management priorities for Refuge resources. It will also promote the Service‟s ecosystem approach to resource management, as well as enhance worldwide scientific connection and understanding. Under all alternatives, effects of promoting management-related research and scientific assessment will have minor to moderate long-term positive impacts on the Service‟s ability to effectively manage the Refuge.

## 6.4.7 Effects of Offering More Visitor Opportunities

Four species of endangered Hawaiian waterbirds are present year-round at Ki„i, which provides visiting public with excellent viewing opportunities for these species. However, ae„o are highly susceptible to disturbance during their nesting season, whereas the other endangered waterbirds are more tolerant. Consequently, docent-led interpretative tours of Ki„i wetlands are conducted only during the ae„o nonbreeding season (October-February). During the interim between present conditions and the development of lands within the expansion boundary, these tours will be continued. Once self-guided tours are in place, docent-led tours will continue, but at a greatly reduced frequency.

### 6.4.7.1 Expanded Visitor Services and Environmental Education Program

Land acquisition will expand the land base of natural resources and facilities, providing greater opportunities for year-round programs at James Campbell NWR, subject to adequate funding and staff. The Refuge is in a unique position to offer local education entities, teachers, and students a place where learning about natural environments, endangered species, natural resource management, conservation issues, and cultural resources occurs in an outdoor setting.

To meet student needs, the Refuge staff is committed to looking for ways to teach about wildlife and habitat conservation. These could be one-time activities such as planting native species, or long-term involvement including planning, design, and actual on the ground implementation of a study or ongoing restoration of a particular site.

James Campbell NWR currently serves 1,500 students and teachers annually. It is estimated that the Refuge could accommodate up to 6,000 students onsite each year if: (1) an education staff were available to run the program full-time; (2) educators were trained and could be recruited to utilize the Refuge during all months of the school year; and (3) the proposed EE facility is funded and constructed. With more opportunities and a more structured program where teachers are trained to use the site and are provided with site-specific materials and tools, educators should be eager to use the Refuge year-round. Although the focus of the program would be outdoors, an indoor facility

would provide lab space and meeting space, particularly during inclement weather. Construction of a HQ/VC/EE complex is proposed for the new acquisition lands near the intersection of Marconi Road and Kamehameha Highway.

Specific details of these activities, compatibility with Refuge purposes and management, locations, etc., will be addressed in a VSP to be completed by the Refuge. Generally speaking, EE is an important aspect of visitor services on refuges. When dealing with sensitive areas, including the presence of threatened and endangered species, opportunities are often limited. They are still important and when supervised and planned appropriately open a new world to youth. We anticipate enlisting students from local high schools and units of the University of Hawai,,i system to participate in gaining firsthand knowledge of science and the scientific method by having them conduct monitoring and restoration projects. These activities will be closely monitored by Refuge and/or Refuge-approved leaders and teachers.

Life history requirements of wildlife, particularly endangered species, and minimizing disturbance to natural resources will be a critical factor in selecting locations for public use programs. Negligible short-term effects are expected because of the small footprint of the participants on any given day and the onsite guidance they will be provided. Long-term beneficial effects will be exposing students to opportunities to experience the outdoors and contribute to the knowledge base of the Refuge. Through these experiences participants will gain a greater appreciation for nature, wild places, environmental processes, and potentially guide them into a science career. The Refuge will benefit from the information gained that will contribute to more effective management of the biotic and abiotic components of this rare coastal community.

Despite the anticipated increased level of visitor services, including EE and interpretation, public tours, wildlife viewing opportunities, and nature photography, effects are expected to be negligible with implementation of either Alternative B or C. When compared to other areas on O,,ahu available for these activities, the consequences to wildlife of increases in public use opportunities at this Refuge would not be noticeable.

The effects of visitor services programs to natural resources, endangered and nonendangered wildlife and plants, and migratory bird species is expected to be negligible as a result of the timing, seasonal access limitations, and limited access and areas available for public use on the Refuge.

#### 6.4.7.2 Construction of Visitor Center, Office, Equipment Building, Bunkhouse, and Greenhouse

Under Alternatives B and C there is a potential for developing a new Complex office, visitor center, bunkhouse, and maintenance buildings for the Refuge. No planning for these structures has been undertaken. If it is determined one or more of these will be built, construction would be timed to minimize effects to natural resources of the Refuge, including daylight work only, seasonal construction restrictions based on nesting endangered species, and minimizing disturbance to neighbors. Details of constructing and maintaining facilities such as these would be subject to a separate environmental compliance process.

Additional traffic congestion along Kamehameha Highway that may result from construction of a new visitor center would be mitigated through highway turnoff redesign (to reduce hazards associated with the Marconi Road intersection). It is anticipated that the majority of visitors to the visitor center will be people already traveling along the highway visiting other popular north shore

destinations. Mitigation measures will be fully developed in a step-down Transportation Plan when funding for this project is available.

#### 6.4.7.3 Entrance and Boundary Sign Installation

Presently there is one entry sign on the entire Refuge. It is located along the main entry to the Ki„i Unit of the Refuge. There is the potential for an additional one or two entry signs depending on locations of future access points to expanded portions of the Refuge. Boundary signs will be placed along the Refuge boundary in compliance with Service policy. The purpose of the aforementioned signage is to inform the public of the presence of the Refuge and delineate the boundary for legal purposes.

Implementation of Alternative B or C will result in negligible short-term effects from use of either manual or mechanized posthole diggers. Disturbance to the ground will be limited to a small several square foot area. Long-term minor positive benefits will be to inform the public the area is a unit of the Refuge System. Installing signs has the potential to adversely affect cultural resources; however, no effects to cultural resources are anticipated from this activity or other management actions for the following reasons.

### 6.4.8 Effects of Increasing Awareness, Protection, and Appreciation of Cultural and Historic Resources

Cultural resources are physical remains, historic sites, objects, records, oral testimony, songs, stories, and traditional life-ways that connect people to past generations. They include archaeological and historic sites, structures, artifacts, landscapes, sacred locations, and oral histories. Cultural resources are integral components of the landscape that serve as anchors for individual and group identity.

Protection, preservation, and respect for cultural resources are integral to management actions considered or planned on the Refuge. The Refuge contracted with the National Park Service to prepare an internal reference document providing an overview of cultural resources on the Refuge entitled “A Cultural Resource Overview Report for the Proposed Expansion of James Campbell National Wildlife Refuge, Kahuku, O„ahu, Hawai„i” in June 2005. This document is not available to the public due to sensitive details pertaining to cultural resources. It describes the environment, land, history, historic eras, previous research and documentation, and recommendations for Refuge management. A predictive model ranks and also identifies areas of potential cultural resources. Associated in this section are recommendations providing guidance to managers during planning and implementation of management actions to adequately address cultural resource issues and actions. This document will be used as a reference and guide during project planning on the Refuge. In addition, State and Federal guidelines will be followed to minimize the chance of harm to cultural resources on the Refuge. In the event of a discovery, any work in progress will cease and coordination with the proper cultural resource specialists will be initiated.

Prior to implementing all ground disturbing projects, the applicable cultural resource compliance investigation would be undertaken. If cultural resources are found, appropriate procedures and protocols would be followed to protect the cultural resources. Whenever possible, resources would be avoided or mitigated. Mitigation options, in addition to site avoidance by relocating or redesigning facilities, would include data recovery, using either collection techniques or in-situ site stabilization protection. Through implementation and adherence to the above guidance and safeguards the effect

of implementing the CCP strategies to cultural resources under all alternatives is anticipated to be none to negligible.

## 6.4.9 Support Flood Damage Reduction Efforts for Town of Kahuku

The Town of Kahuku is within the lower portion of the Mālaekahana and ʻŌhiʻa Streams watersheds. Portions of Kahuku and much of the Refuge lie within the 100-year flood zones of these streams and the coastal floodplain, thereby subject to flooding and associated flood damage during exceptionally heavy rainfall. In an attempt to identify means to reduce flood damages in Kahuku, USACE completed the Kahuku Watershed Feasibility Study in 2006. This study did not identify any comprehensive flood control or flood damage mitigation projects which would meet cost/benefit requirements for federal funding. Since that time, various community groups or organizations have continued to develop and propose ideas for potential flood mitigation projects. The James Campbell Expansion Act of 2005 did include a "finding" supporting the Act that in addition to other identified management priorities, the purchase of new Refuge lands "is necessary to reduce flood damage following heavy rainfall to residences, businesses, and public buildings in the town of Kahuku". The Refuge will continue to participate and cooperate in community and agency efforts to address flood damage reduction for the local area. Any future proposed projects which would involve/impact Refuge lands would be subject to a separate environmental review and regulatory process from this CCP.

## 6.4.10 Economic Impacts

National wildlife refuges provide many services to people. A complete economic analysis of the Refuge System includes not only the value of all the forms of recreation enjoyed but also the payrolls of Refuge employees and the values of maintaining endangered species, preserving wetlands, educating future generations, and adding stability to our ecosystem. All of these services are of value to society, whether or not they result in some form of market transaction. Some people gain value simply from knowing that wild places and unique species still exist.

For the regional economy, the source of the spending matters. If the expenditure is from outside the region, it generates increased economic activity. If it is from within the region and would have occurred in the region anyway, it does not increase economic activity but is important for local businesses. Thus it is important to separate spending by people from outside the Refuge's economic region from spending by those who live locally. Local residents would probably have spent their recreation money in the local economy with or without the Refuge. In contrast, non-residents may have been attracted to the area by the Refuge. They would have gone elsewhere except for its presence, and their spending is a stimulus to the economy. Non-resident spending generates new income and new jobs (Carver and Caudill 2007).

Implementation of either Alternative B or C would be expected to result in minor positive benefits in expenditures in the local economy due to construction spending and higher visitation levels. These visitors are likely to frequent local businesses for food and other amenities not provided at the Refuge. The Hawaiʻi DBEDT states, "Tourism is the activity most responsible for Hawaiʻi's current economic growth and standard of living." Additional visitors are expected to have a minor positive benefit to the local Haleʻiwa and Kahuku business communities and provide tourism companies throughout the island with an additional venue to bring their clientele. Major construction projects, if funded, could have short-term intermediate positive benefits if local contractors have successful bids

to do the work. There could also be short-term positive benefits if the contractors hire local labors for the projects. The 12 additional staff positions identified in this plan, if filled, would have a long-term minor positive benefit on local employment and personal expenditures.

### 6.4.11 Environmental Justice

The concept of environmental justice has been around since the early 1990s and arose from a need to ensure that negative environmental activities from industry or government projects would not endanger local communities. The EPA oversees environmental justice compliance and defines environmental justice as: "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (USEPA 2010).

In keeping with the Ko,,olau Loa Sustainable Communities Plan, expansion of the Refuge to protect 1,100 acres of open space along the island"s north shore will preserve scenic open space and natural resources from encroachment of development, thereby protecting the rural character of the region. Restoration of the expansion lands to native vegetation and wetlands and the return of native species will enhance spectacular natural, scenic, and cultural qualities.

Since CCP implementation of any of the alternatives is expected to result in generally positive effects on the human environment, there would be little risk of disproportionate negative effects to low income or minority groups. Therefore, negligible effects related to environmental justice are anticipated under all CCP alternatives.

## 6.5 Global Climate Changes and Projections

Global climate change is supported by a continuously growing body of unequivocal scientific evidence. The Intergovernmental Panel on Climate Change (IPCC) is a scientific intergovernmental body organized by the World Meteorological Organization and the United Nations Environment Programme in order to assess the causes, impacts, and response strategies to changes in climatic conditions. According to the Fourth Assessment Report by the IPCC, global temperatures on the Earth"s surface have increased by 1.33°F over the last 100 years. This warming trend has accelerated within the last 50 years, increasing by 0.23°F each decade. Global ocean temperatures to a depth of almost 2,300 feet have also increased, rising by 0.18°F between 1961 and 2003 (Solomon et al. 2007).

Global forecasting models offer a variety of predictions based on different emission scenarios. The U.S. Government agency Overseas Private Investment Corporation (OPIC) suggests that a further increase in greenhouse gas (GHG) emissions could double atmospheric concentrations of $CO_2$ by 2060 and subsequently increase temperatures by as much as 2-6.5°F over the next century. Recent model experiments by the IPCC show that if GHGs and other emissions remain at 2000 levels, a further global average temperature warming of about 0.18°F per decade is expected. Sea level rise (SLR) is expected to accelerate by two to five times the current rates due to both ocean thermal expansion and the melting of glaciers and polar ice caps. Recent modeling projects sea level to rise 0.59-1.93 feet by the end of the 21$^{st}$ century. These changes may lead to more severe weather, shifts in ocean circulation (currents, upwelling), as well as adverse impacts to economies and human health. The extent and ultimate impact these changes will have on Earth"s environment remains under considerable debate (OPIC 2000, Buddemeier et al. 2004, Solomon et al. 2007, IPCC 2007).

### 6.5.1 Climate Change in Hawai‘i

Small island groups are particularly vulnerable to climate change. The following characteristics contribute to this vulnerability: (1) small emergent land area compared to the large expanses of surrounding ocean; (2) limited natural resources; high susceptibility to natural disasters; and (3) inadequate funds to mitigate impacts (IPCC 2001). Thus, Hawai„i is considered to have a limited capacity to adapt to future climate changes. The Pacific Islands Regional Integrated Science and Assessment is working to develop programs dealing with climate risk management in the Pacific region. The Service is supporting the development of regional Landscape Conservation Cooperatives that will integrate local climate models with models of climate-change responses by species, habitats, and ecosystems. The regional version of these Landscape Conservation Cooperatives is the Pacific Islands Climate Change Cooperative (PICCC), headquartered in Honolulu, Hawai„i, but working across the Pacific. The PICCC was established in 2010 to assist those who manage native species, island ecosystems, and key cultural resources in adapting their management to climate change for the continuing benefit of the people of the Pacific Islands. The PICCC steering committee consists of more than 25 Federal, State, private, indigenous, nongovernmental conservation organizations, and academic institutions, forming a cooperative partnership that determines the overall organizational vision, mission, and goals (IPCC 2007).

Similar to the rest of the world, temperatures in Hawai„i are rising. The EPA has estimated that the average surface temperature in Honolulu, Hawai„i has increased by 4.4°F over the last century. In particular, nighttime temperatures are notably warmer, increasing by about 0.5°F per decade over the past 30 years. Recent studies have shown that this rising average night temperature is greater at high elevation sites than lower areas. Sea surface temperature near the islands has been increasing recently, showing a 0.72°F rise between 1957-1987. Sea level around the Hawaiian Islands is rising by 6-14 inches per century. Over the last 90 years, precipitation has also decreased approximately 20 percent (EPA 1998, Arakawa 2008, Giambelluca 2008).

As a result of these shifts, Hawai„i is developing means to reduce its GHG emissions. In 1990, it is estimated that 15,985,225 tons of $CO_2$ were emitted in Hawai„i. Other major GHG released that year include 75,736 tons of methane ($CH_4$) and 690 tons of nitrous oxide ($N_2O$). These estimates do not include fuels that were exported, used on international aircraft or ship operations, or used by the military in the State. International, military, and overseas $CO_2$ emissions were estimated to be 7,363,261 tons in 1990 (DBEDT and DOH 1999). In 2007, the State of Hawai„i enacted Act 234, which sets the goal to reduce GHG emissions to 1990 levels by 2020.

Global and regional predictive climate simulations may not capture unique and important features of the Hawaiian climate. Existing large-scale models show large variability and uncertainty for the Hawaiian Islands; thus, applying these models to predict local conditions must be done with caution until more fine scaled models are developed. Models from the IPCC and United Kingdom Hadley Centre‟s climate model suggested that by 2100 annual temperatures in Hawai„i could increase by 3°F, with a slightly higher increase in fall. Other estimates predict a 5-9°F rise by the end of the 21st century. Future changes in precipitation are uncertain, dependent largely on shifts in El Niño/La Niña events. Some predictions forecast an additional rise of 17-25 inches by 2100, while others suggested decreased precipitation (TenBruggencate 2007, Timm 2008).

Projected impacts that may have a significant effect on the coastal national wildlife refuges on O„ahu are discussed below.

## 6.5.2 Sea Level Rise

According to the IPCC, the oceans are now absorbing more than 80 percent of the heat added to the Earth‟s climate system. Since 1961, this absorption has caused average global ocean temperatures to increase and seawater to expand. Thermal expansion of the sea is the primary cause of global sea level changes. Melting ice-sheets, ice caps, and alpine glaciers also influence ocean levels. Worldwide, sea level changes have historically occurred on a small scale; however, scientific evidence suggests that the current, accelerated rate of global change began between the mid-1800s and 1900s. Similarly, sea levels in the Pacific have regularly changed over the centuries due to variations in solar radiation. Since 1800, sea levels in the Pacific region have been rising. During the last century, these levels have risen about 6 inches and this is likely to rapidly increase in the next century (Noye and Grzechnik 2001, GAO 2007).

Due to localized geographic and oceanographic variations, it is not possible to discuss SLR on a global scale. Near Pacific Island ecosystems, SLR is influenced by the rate and extent of global sea level rise, as well as changes in episodic events, such as the El Niño Southern Oscillation and storm-related conditions. Topography and exposure to normal and storm swell produce localized differences. Furthermore, it is important to note that shoreline sea levels are historically and currently influenced by isostatic tectonic changes as the islands move with the Pacific Plate, which are not due to global changes in sea level. Thus, sea level change in the Pacific is highly variable due to geologic uplift (Michener et al. 1997, Carter et al 2001).

Hawai„i‟s sea level appears to be rising at a slower rate than the global seas. Based on tide gauge records at the Honolulu Harbor, the sea level surrounding O„ahu has risen at a rate of 0.0551 in per year. Geological uplift contributes about 0.0016 in per year. The University of Hawai„i Sea Level Center has estimated that 1905-2006 mean sea level rose about 0.0417 inches per year. A similar estimate was derived from shallow core measurements of a fringing reef crest at Hanauma Bay, which concluded that the island is subsiding at a rate of 0.0394-0.0787 in per year. Although most of this rise is due to isostatic sinking of the tectonic plate, global-warming induced SLR has the potential to intensify this rise (Nakiboglu et al. 1983, Caccamise et al. 2005).

In an effort to address the potential effects of SLR on national wildlife refuges, the Service contracted the application of the Sea Level Affects Marshes Model (SLAMM) 6 for several Pacific Region refuges. This analysis is designed to assist in development of long-term management plans. The SLAMM model predictions for James Campbell NWR suggest that inland inundation within this Refuge will occur given SLR scenarios of approximately 1.6 ft (eustatic) and beyond. There are two major channels through which saline inundation will occur; Bacahan channel at the northeast of the site and Ki„i Outlet channel in the region of the Refuge‟s pumphouse.

Model results suggest that much of the coastal dune area could become inundated in higher SLR scenarios. These inundated areas include the Kahuku Airstrip and areas south and east of the strip. Unlike the rest of the coast, inundated zones near the airstrip are not protected by high dunes. There does remain some uncertainty as to land disposition after flooding. SLAMM assumes that land close to the ocean will convert to beach and inland regions will convert to transitional salt marshes, salt marshes, and mudflats. All of these predictions are estimated 50-100 years in the future, well beyond the scope of this CCP.

There is always uncertainty about how regularly flooded wetlands will respond to the signal of increased SLR. The most important effects of SLR at the James Campbell NWR are the gradual inundation and flooding of historic wetlands and dryland areas, as well as increases in the salinity of wetlands. Salinity alterations have the potential to shift aquatic plants and animal communities that do not tolerate high salinity. Higher sea levels may inundate these low-lying land areas, potentially helping Refuge personnel to reclaim/restore former wetland areas for endangered waterbirds.

### 6.5.3 Climate Change Effects on Water Resources

The impact of climate change on water resources is dependent on shifts in precipitation amounts, evaporation rates, storms, and events such as the El Niño Southern Oscillation (ENSO). This is an ocean-atmosphere phenomenon in which the normal oceanic and atmospheric circulation patterns of the Pacific Ocean temporarily collapse. During normal years, strong trade winds move counterclockwise in the southern hemisphere and clockwise in the northern hemisphere, causing surface water to move westward. These winds also produce upwelling that brings high nutrient waters to the surface. During ENSO, trade winds in the western Pacific stop and the warm mass of water in the west moves eastward, causing shifts in the location of evaporation. As a result, heavy rains occur in normally dry areas such as the central Pacific islands. In addition to more precipitation, these winds bring upwelling of warm water, which is devoid of nutrients. This causes productive communities to collapse and subsequent death of fish and birds.

While ENSO events have increased in intensity and frequency over the past decades, some longer-term records have not found a direct link to global warming and do not predict significant changes in ENSO; however, a majority of climate forecasts do suggest an evolution toward more "El Niño-like" patterns. Most climate projections reveal that this trend is likely to increase rapidly in the next 50 years. However, other models predict more "La Niña-like" conditions in the Hawaiian Islands (Walther et al. 2002, Buddemeier et al. 2004, Timm 2008).

A trend toward ENSO patterns will impact sea levels, sea temperatures, rainfall amounts, evaporation rates, and the occurrence of hurricanes; however, the exact impact of climate change on water resources is difficult to predict due to spatial variability. On a global scale, mean precipitation is anticipated to increase. Current climate models project that tropical Pacific and high latitude areas will experience increasing precipitation amounts, while precipitation is likely to decrease in most subtropical regions. A current trend toward this increase is supported by lowered salinity levels in both the mid- and high-latitude oceanic waters. If the opposite effect takes place, decreasing precipitation or increasing evaporation will further stress meager surface and groundwater resources. Lack of rain could lower the amount of freshwater lens recharge and decrease available water supplies. Reduced rainfall or increased evaporation will cause a corresponding increase in the demand for residential, commercial, or agricultural water (Giambelluca et al. 1996, Solomon et al. 2007, Parry et al. 2007).

Most climate projections suggest that more intense wind speeds and precipitation amounts will accompany more frequent tropical typhoons/cyclones and increased tropical sea surface temperatures in the next 50 years. The Third Assessment of the IPCC (2001) has concluded with "Intermediate confidence" that the intensity of tropical cyclones is likely to increase by 10-20 percent in the Pacific region when atmospheric levels of $CO_2$ reach double preindustrial levels (McCarthy et al. 2001). One model projects a doubling of the frequency of 4 inches per day rainfall events and a 15-18 percent increase in rainfall intensity over large areas of the Pacific. Solomon et al. (2007) states that it is

"more likely than not" that the rise in intense tropical cyclones is due to anthropogenic activity (Walther et al. 2002, Solomon et al. 2007).

An increase in heavy storms and surf will result in increased flood risks, sedimentation, and impeded drainage in Hawai„i. In particular, the low-elevation Refuge units will be vulnerable to changes in storm frequency, intensity, and directionality. These events have the potential to denude vegetation or affect the biogeochemistry of the wetlands (DBEDT and DOH 1999).

### 6.5.4 Ecological Responses to Climate Change

Evidence suggests that recent climatic changes have affected a broad range of individual species and populations in both the marine and terrestrial environment. Organisms have responded by changes in phenology (timing of seasonal activities) and physiology; range and distribution; community composition and interaction; and ecosystem structure and dynamics. The reproductive physiology and population dynamics of amphibians and reptiles are highly influenced by environmental conditions such as temperature and humidity. For example, sea turtle sex is determined by the temperature of the nest environment; thus, higher temperatures could result in a higher female to male ratio. In addition, increases in atmospheric temperatures during seabird nesting seasons will also have an effect on seabirds and water birds (Duffy 1993, Walther et al. 2002, Baker et al. 2006).

Changes in ocean temperature, circulation, and storm surge due to climate change will impact seabird breeding and foraging. The ENSO has been shown to cause seabirds to abandon habitats, nest sites, and foraging areas for colder/warmer waters. Studies have found that nesting success is reduced for some species during this climatic event. Oceanographic changes associated with ENSO may also increase or decrease food supply for seabirds and subsequently impact populations that forage offshore. Shifts in marine temperature, salinity, turbidity, currents, depth, and nutrients will have an impact on seabird and water bird prey composition and availability. Although these potential changes may impact seabirds throughout the Hawaiian Islands, contrary evidence suggests that seabirds may have coped with and evolved around climatic changes in the past (Duffy 1993).

Warming has also caused species to shift toward the poles or higher altitudes and changes in climatic conditions can alter community composition. For example, increases in nitrogen availability can favor those plant species that respond to nitrogen rises. Similarly, increases in $CO_2$ levels can impact plant photosynthetic rates, decrease nutrient levels, and lower herbivore weights. Although there is uncertainty regarding these trajectories, it is probable that there will be ecological consequences (Vitousek 1994, Walther et al. 2002, Ehleringer et al. 2002).

Climate change has the potential to influence two important ecological issues in the State of Hawai„i: endangered species and pest species. The majority of U.S. endangered species are found in the State of Hawai„i. Species declines have resulted from habitat loss, introduced diseases, and impacts from pest species. Changes in climate will add an additional threat to the survival of these species. For example, warmer night temperatures can increase the rate of respiration for native vegetation, resulting in greater competition from pest plants. Furthermore, climate change may enhance existing pest species issues because alterations in the environment may increase the dispersal ability of flora or fauna. Species response to climate change will depend on the life-history, distribution, dispersal ability, and reproduction requirements of the species (DBEDT and DOH 1998, Middleton 2006, Giambelluca 2008).

## 6.6 Cumulative Effects Assessment

Cumulative impacts are the overall, net effects on a resource that arise from multiple actions. Impacts can "accumulate" spatially, when different actions affect different areas of the same resources. They can also accumulate over the course of time, from actions in the past, the present, and the future.

Occasionally, different actions counterbalance one another, partially canceling out each other"s effect on a resource. But more typically, multiple effects add up, with each additional action contributing an incremental impact on the resource. In addition, sometimes the overall effect is greater than merely the sum of the individual effects, such as when one more reduction in a population crosses a threshold of reproductive sustainability, and threatens to extinguish the population.

A thorough analysis of impacts always considers their cumulative aspects, because actions do not take place in a vacuum; there are virtually always some other actions that have affected that resource in some way in the past, or are affecting it in the present, or will affect it in the reasonably foreseeable future. So any assessment of a specific action"s effects must in fact be made with consideration of what else has happened to that resource, what else is happening, or what else will likely happen to it.

The Refuge staff is not aware of any past, present, or planned actions within the next 15 years that would result in a significant cumulative impact when added to the Refuge"s proposed actions, as outlined in the proposed alternatives. The actions proposed by the Refuge in this CCP are expected to contribute negligible or minor effects to cumulative impacts of any flood damage reduction project, resort and subdivision development, wind farms, and military projects.

# Appendix A: James Campbell NWR Species Lists

| Common Name | Scientific name | Hawaiian Name |
|---|---|---|
| **Mammals** | | |
| Hawaiian monk seal | *Monachus schauinslandi* | ʻĪlio-holo-i-ka-uaua |
| Hawaiian hoary bat | *Lasiurus cinereus semotus* | ʻŌpeʻapeʻa |
| Dog | *Canis familiaris* | ʻĪlio |
| Cat | *Felis catus* | Pōpoki |
| Indian mongoose | *Herpestes auropunctatus* | Manakuke |
| House mouse | *Mus musculus* | ʻIole |
| Polynesian rat | *Rattus exulans* | ʻIole |
| Norway rat | *Rattus norvegicus* | ʻIole |
| Black rat | *Rattus rattus* | ʻIole |
| Pig | *Sus scrofa* | Puaʻa |
| **Marine Reptiles** | | |
| Green sea turtle | *Chelonia mydas* | Honu |
| **Fish** | | |
| Western Mosquitofish | *Gambusia affinis* | Iʻa makika |
| Milkfish | *Chanos chanos* | Awa |
| Cuban molly | *Limia vittata* | |
| Engel's mullet | *Moolgarda engeli* | |
| Mullet | *Mugil cephalus* | ʻAmaʻama |
| Acute-jawed mullet | *Neomyxus leuciscus* | |
| Molly | *Poecilia hybrid sp.* | |
| Sailfin molly | *Poecilia latipinna* | |
| Shortfin molly | *Poecilia mexicana* | |
| Gracile lizardfish | *Saurida gracilis* | |
| Black chin tilapia | *Sarotherodon melanotheron* | |
| Tilapia | *Oreochromis mossambicus* | |
| Tipapia | *Tilapia zillii* | |
| Giant trevally (papio) | *Caranx Ignobilis* | Ulua au kea |
| **Invertebrates, aquatic** | | |
| Asian clam | *Corbicula fluminea* | |
| Clam | *Corbicula sp.* | |
| Anchialine snapping shrimp | *Metabetaeus lohena* | |
| Hawaiian red shrimp | *Halocaradiana rubra* | ʻŌpaeʻula |
| Feeble shrimp | *Palaemon debilis* | ʻŌpae huna |
| Limpet | *Pyrgophorus coronatus* | ʻOpihi |
| Mud crab | *Scylla serreta* | |
| Crenate swimming crab | *Thalamita crenata* | |
| | *Thalamita edwardsi* | |
| Crayfish | *Procambarus clarkii* | ʻŌpae pake |
| Freshwater prawn | *Macrobrachium rosenbergii* | |
| **Invertebrates, terrestrial** | | |
| Southern house mosquito | *Culex quinquefasciatus* | |

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|---|---|---|
| Asian tiger mosquito | *Aedes albopictus* | |
| Waterstrider | *Halobates hawaiiensis* | |
| Cane spider | *Heteropoda venatoria* | |
| Rambur's forktail damselfly | *Ischnura ramburii* | |
| Lesser brown scorpion | *Isometrus maculatus* | Kopiana |
| Centipede | *Scolopendra subspinipes* | Kanapī |
| **Reptiles and Amphibians** | | |
| American bullfrog | *Rana catesbeiana* | |
| Blind Snake | *Ramphotyphlops braminus* | |
| Cane toad | *Bufo marinua* | Poloka |
| Common house gecko | *Hemidactylus frenatus* | Mo‘o ‘alā |
| Green Anole Lizard | *Anolis carolinensis porcatus* | |
| Garden Skink | *Lampropholis delicata* | |
| Red-eared slider | *Trachemys scripta elegans* | |

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|---|---|---|
| **Migratory shorebirds** | | |
| **Plovers & Dotterels** | | |
| Black-bellied Plover | *Pluvialis squatarola* | |
| Pacific Golden-Plover | *Pluvialis fulva* | Kōlea |
| Semipalmated Plover | *Charadrius semipalmatus* | |
| Killdeer | *Charadrius vociferus* | |
| **Avocets & Stilts** | | |
| Hawaiian Stilt | *Himantopus mexicanus knudseni* | Ae‘o |
| **Sandpipers & Phalaropes** | | |
| Greater Yellowlegs | *Tringa melanoleuca* | |
| Lesser Yellowlegs | *Tringa flavipes* | |
| Wandering Tattler | *Heteorscelus incanus* | ‘Ūlilī |
| Spotted Sandpiper | *Actitis maclaria* | |
| Black-tailed Godwit | *Limosa limosa* | |
| Bar-tailed Godwit | *Limosa lapponica* | |
| Ruddy Turnstone | *Arenaria interpres* | ‘Akekeke |
| Red Knot | *Calidris canutus* | |
| Sanderling | *Calidris alba* | Hunakai |
| Semipalmated Sandpiper | *Calidris pusilla* | |
| Western Sandpiper | *Calidris mauri* | |
| Least Sandpiper | *Calidris minutilla* | |
| Pectoral Sandpiper | *Calidris melanotos* | |
| Sharp-tailed Sandpiper | *Calidris acuminata* | |
| Solitary Sandpiper | *Tringa solitaria* | |
| Marsh Sandpiper | *Tringa stagnatilis* | |
| Dunlin | *Calidris alpina* | |
| Stilt Sandpiper | *Calidris himantopus* | |
| Ruff | *Philomachus pugnax* | |
| Short-billed Dowitcher | *Limnodromus griseus* | |
| Long-billed Dowitcher | *Limnodromus scolopaceus* | |
| Common Snipe | *Gallinago gallinago* | |

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|---|---|---|
| Wilson's Phalarope | *Phalaropus tricolor* | |
| **Seabirds & Gulls** | | |
| Laysan Albatross | *Phoebastria immutabilis* | Mōlī |
| Black-footed Albatross | *Phoebastria nigripes* | ʻKaʻupu |
| Wedge-tailed Shearwater | *Puffinus pacificus* | ʻUaʻu kani |
| White-tailed Tropicbird | *Phaethon lepturus dorotheae* | Koaʻe kea |
| Red-tailed Tropicbird | *Phaethon rubricauda* | Koaʻeʻula |
| Red-footed Booby | *Sula sula rubripes* | ʻĀ |
| Great frigatebird | *Fregata minor* | ʻIwa |
| Laughing gull | *Leucophaeus atricilla* | |
| Franklin's Gull | *Laris pipixcan* | |
| Bonaparte's gull | *Chroicocephalus philadelphia* | |
| Ring-billed gull | *Larus delawarensis* | |
| Herring gull | *Larus argentatus* | |
| Thayer's Gull | *Larus thayeri* | |
| Western Gull | *Larus occidentalis* | |
| Glaucous-winged Gull | *Larus glaucescens* | |
| Gull-billed Tern | *Gelochelidon nilotica* | |
| Caspian Tern | *Hydroprogne caspia* | |
| Sandwich Tern | *Thalasseus sandvicensis* | |
| Common Tern | *Sterna hirundo* | |
| Arctic Tern | *Sterna paradisaea* | |
| Least Tern | *Sternula antillarum* | |
| White Tern, Fairy Tern | *Gygis alba* | Manu o Kū |
| **Herons & Ibis** | | |
| Great blue heron | *Ardea herodias* | |
| Snowy egret | *Egretta thula* | |
| Cattle egret | *Bubulcus ibis* | |
| Black-crowned night-heron | *Nycticorax nycticorax* | ʻAukuʻu |
| White-faced ibis | *Plegadis chihi* | |
| **Geese & Ducks** | | |
| Greater white-fronted goose | *Anser albifrons* | |
| Black brant | *Branta bernicla* | |
| Cackling goose | *Branta hutchinsii* | |
| Canada goose | *Branta canadensis* | |
| Gadwall | *Anas strepera* | |
| Eurasian widgeon | *Anas penelope* | |
| American widgeon | *Anas americana* | |
| Mallard | *Anas platyrhynchos* | |
| Hawaiian duck | *Anas wyvilliana* | Koloa maoli |
| Blue-winged teal | *Anas discors* | |
| Cinnamon Teal | *Anas cyanoptera* | |
| Northern shoveler | *Anas clypeata* | Koloa mohā |
| Northern pintail | *Anas acuta* | Koloa māpu |
| Green-winged teal | *Anas carolinensis* | |

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|---|---|---|
| Canvasback | *Aythya valisineria* | |
| Redhead | *Aythya americana* | |
| Ring-necked duck | *Aythya collaris* | |
| Tufted duck | *Aythya fuligula* | |
| Greater scaup | *Aythya marila* | |
| Lesser scaup | *Aythya affinis* | |
| Bufflehead | *Bucephala albeola* | |
| Common Merganser | *Mergus merganser* | |

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|---|---|---|
| **Diurnal Raptors** | | |
| Osprey | *Pandion haliaetus* | |
| Northern harrier | *Circus cyaneus* | |
| Peregrine falcon | *Falco peregrinus* | |
| **Upland Game Birds** | | |
| Ring-necked pheasant | *Phasianus colchicus* | |
| Common peafowl | *Pavo cristatus* | Pīkake |
| Guinea fowl | *Numida meleagris* | |
| **Gallinules & Coots** | | |
| Hawaiian moorhen | *Gallinula chloropus sandvicensis* | ʻAlae ʻula |
| Hawaiian coot | *Fulica alai* | ʻAlae keʻokeʻo |
| **Pigeons & Doves** | | |
| Rock pigeon | *Columba livia* | |
| Spotted dove | *Streptopelia chinensis* | |
| Zebra dove | *Geopelia striata* | |
| Mourning dove | *Zenaida macroura* | |
| **Parrots** | | |
| Sulphur-crested Cockatoo | *Cacatua galerita* | |
| **Owls** | | |
| Barn owl | *Tyto alba* | |
| Hawaiian Short-eared Owl | *Asio flammeus sandwichensis* | Pueo |
| **Bulbuls** | | |
| Red-vented bulbul | *Pycnonotus cafer* | |
| **Bush-warblers** | | |
| Japanese bush-warbler | *Cettia diphone* | |
| White-rumped shama | *Copsychus malabaricus* | |
| **Mynas** | | |
| Common myna | *Acridotheres tristis* | |
| **White-eyes** | | |
| Japanese white-eye | *Zosterops japonicus* | |
| **Cardinals** | | |
| Northern cardinal | *Cardinalis cardinalis* | |
| Red-crested cardinal | *Paroaria coronata* | |
| **Finches** | | |
| House finch | *Carpodacus mexicanus* | |

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|---|---|---|
| **Sparrows** | | |
| House sparrow | *Passer domesticus* | |
| Java sparrow | *Padda oryzivora* | |
| **Waxbills & Mannikins** | | |
| Common waxbill | *Estrilda astrild* | |
| Red avadavat | *Amandava amandava* | |
| Nutmeg mannikin | *Lonchura punctulata* | |
| Chestnut munia | *Lonchura atricapilla* | |

| **Native Plant Species** | | | |
|---|---|---|---|
| **Scientific Name** | **Common Name** | **Origin** | **Hawaiian Name** |
| Aizoaceae | | | |
| *Sesuvium portulacastrum* | Sea purslane | Ind. | ʻĀkulikuli |
| Astererace | | | |
| *Lipochaeta lobata* | Daisy | End. | Nehe |
| Boraginaceae | | | |
| *Heliotropium anomalum* var. *argenterum* | Hinahina | Ind. | Hinahina |
| *Heliotropium curassavicum* | Seaside heliotrope | Ind. | Kīpūkai |
| Chenopodiaceae | | | |
| *Chenopodium oahuense* | Aheahea | End. | ʻĀheahea |
| Convolvulaceae | | | |
| *Ipomoea imperati* | Beach morning glory | Ind. | Hunakai |
| *Ipomoea indica* | Koaliʻawa | Ind. | Koaliʻawa |
| *Ipomoea pes-carprae* | Beach morning glory | Ind. | Pōhuehue |
| *Jaquemontia ovalifolia* | Oval-leafed clustervine | Ind. | Pāʻūohiʻiaka |
| Cyperaceae | | | |
| *Bolboschoenus maritimus* | Kaluha | Ind. | Kaluhā |
| *Mariscus javanicus* | Marsh cyprus | Ind. | ʻAhuʻawa |
| *Cyperus polystachyos* | Manyspike flatsedge | Ind. | |
| *Schoenoplectus lacustris* | Great bulrush | Ind. | ʻAkaʻakai |
| *Fimbristylis cymosa* | Sand Bulrush | Ind. | Mauʻu |
| Euphorbiaceae | | | |
| *Chamaesyce degeneri* | Beach sandmat | End. | ʻAkoko |
| Fabaceae | | | |
| *Erythrina sandwicensis* | Hawaiian coral tree | End. | Wiliwili |
| *Vigna marina* | Beach pea | Ind. | Nanea |
| Malvaceae | | | |
| *Gossypium tomentosum* | Hawaiian cotton | End. | Mao |
| *Sida fallax* | Yellow ilima | Ind. | ʻIlima |
| *Thespesia populnea* | Milo | Ind. | Milo |
| Menispermaceae | | | |
| *Cocculus trilobus* | Huehue | Ind. | Huehue |
| Nyctaginaceae | | | |
| *Boerhavia repens* | Alena | Ind. | Alena |
| Onagraceae | | | |

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|---|---|---|---|
| *Ludwigia octovalvis* | Primrose willow | Ind. | Kāmole |
| Plumbaginaceae | | | |
| *Plumbago zeylandica* | ʻIlieʻe | Ind. | ʻIlieʻe |
| Pandanaceace | | | |
| *Pandanus tectorius* | Screw pine | Ind. | Hala |
| Poaceae | | | |
| *Sporobolus virginicus* | Beach dropseed | Ind. | ʻAkiʻaki |
| Santalaceae | | | |
| *Santalum ellipticum* | Coastal sandalwood | End. | ʻIliahialoʻe |
| Scrophulariaceae | | | |
| *Bacopa monnieri* | Water hyssop | Ind. | ʻAeʻae |
| Solanaceae | | | |
| *Lycium sandwicense* | Hawaiian desert-thorn | Ind. | ʻOhelo kai |
| *Solanum americanum* | Popolo | Ind. | Popolo |
| Sterculiaceae | | | |
| *Waltheria indica* | ʻUhaloa | Ind. | ʻUhaloa |
| Verbanaceae | | | |
| *Vitex rotundifolia* | Beach vitex | Ind. | Pōhinahina |
| *Scaevola taccada* | Beach naupaka | Ind. | Naupaka kahakai |

* The taxonomy and nomenclature of the plants are in accordance with Wagner et al. (1999).

| **Nonnative Plants** | | |
|---|---|---|
| **Scientific Name** | **Common Name** | **Hawaiian Name** |
| *Abutilon grandifolium* | Hairy abutilon | |
| *Achyranthes aspera* | Achyranthes | |
| *Alternanthera pungens* | Khaki weed | |
| *Amaranthus viridis* | Slender amaranth | |
| *Amaranthus spinosus* | Spiny amaranth | Pakai kuku |
| *Anagallis arvensis* | Scarlet pimpernel | |
| *Asystasia gangetica* | Chinese violet | |
| *Atriplex semibacatta* | Australian saltbush | |
| *Atriplex suberecta* | Saltbush | |
| *Batis maritima* | Saltwort, pickleweed, batis | ʻAkulikuli |
| *Bidens alba* | Beggartick | |
| *Boerhavia coccinea* | Red spiderling | |
| *Blutaparon vermiculare* | Silverhead | |
| *Brachiaria mutica* | California grass | |
| *Casuarina equisetifolia* | Ironwood | |

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|---|---|---|
| *Cenchrus echinatus* | Sandbur | |
| *Centaurium erythraea* | Bitter herb | |
| *Centella asiatica* | Asiatic pennywort | |
| *Chamaesyce prostrata* | Prostrate spurge | |
| *Chamaesyce hyssopifolia* | Small hyssopleaf sandmat | |
| *Chloris barbata* | Swollen finger grass | |
| *Coccoloba uvifera* | Sea grape | |
| *Cordia subcordata* | Sea trumpet | Kou |
| *Casuarina equisetifolia* | Ironwood | |
| *Coccinia grandis* | Ivy gourd | |
| *Cocos nucifera* | Coconut palm | Niu |
| *Commelina diffusa* | Dayflower | Honohono |
| *Cordyline fruticosa* | Ti | Kī |
| *Cynodon* dactylon. | Bermuda grass | |
| *Cyperus* sp. | Sedge | |
| *Cyperus alterniflorius* | Umbrella sedge | |
| *Cyperus difformis* | Variable flatsedge | |
| *Echinochloa* sp. | Wild millet, millet | |
| *Eleocharis geniculata* | Spikerush, bent spikerush | |
| *Eragrostis* sp. | Lovegrass | Kawelu |
| *Fimbristylis milliacea* | Grass-like fimbry | |
| *Fimbristylis ferruginea* | West Indian fimbry | |
| *Fimbristylis dichotoma* | Forked fimbry | |
| *Lantana camera* | Lantana | |
| *Leonotis nepetaefolia* | Lion’s ear | |
| *Leptochloa uninervia* | Sprangletop | |
| *Leucana leucocephala* | White leadtree | Koa haole |
| *Macaranga tanarius* | Macaranga | |
| *Mimosa pudica* | Sensitive mimosa | Hilahila |
| *Nymphaea ssp.* | Water lily | |
| *Panicum maximum* | Guinea grass | |

| | | |
|---|---|---|
| *Paspalum disticum* | Knot-grass | |
| *Plantago major* | Broad-leafed plantago | Laukahi |
| *Pluchea* x *fosbergii* | Marsh fleabane | |
| *Pluchea indica* | Indian marsh fleabane | |
| *Pluchea symphytifolia* | Sourbush | |
| *Prosopis pallida* | Mesquite | Kiawe |
| *Rhizophora mangle* | Red mangrove | |
| *Ricinus communis* | Castor bean | |
| *Schinus terebinthifolius* | Christmas berry | |
| *Schlefflera actinophylla* | Octopus tree | |
| Schoenoplectus *californicus* | California bulrush | |
| *Solanum torvum* | Turkey berry | |
| *Solanum linnaeum* | Apple of Sodom | |
| *Sonchus oleraceus* | Sow thistle | |
| *Terminalia catappa* | False kamani | |
| *Tournefortia argentea* | Tree heliotrope | |
| *Typha* sp. | Cattail | |
| *Verbesina enchiloides* | Golden crownbeard | |
| *Xanthium strumarium* | Cocklebur | Kīkānia |

# Appendix B. Compatibility Determinations and Appropriate Use Findings

## B.1 Introduction

The compatibility determinations (CDs) developed during the CCP planning process evaluate uses projected to occur at the James Campbell NWR over the next 15 years. The evaluation of funds needed for management and implementation of each use also assumes implementation as described in Chapter 2. Chapter 6 of the Draft CCP/EA also contains analysis of the impacts of public uses to wildlife and habitats.

### B.1.1 Uses Evaluated At This Time

The following section includes full CDs for all Refuge uses that are required to be evaluated at this time. According to Service policy, CDs will be completed for all uses proposed under a CCP that have been determined to be appropriate. Existing wildlife-dependent recreational uses must also be reevaluated and new CDs prepared during development of a CCP. According to the Service's compatibility policy, uses other than wildlife-dependent recreational uses are not explicitly required to be reevaluated in concert with preparation of a CCP, unless conditions of the use have changed or unless significant new information relative to the use and its effects have become available or the existing CDs are more than 10 years old. However, the Service planning policy recommends preparing CDs for all individual uses, specific use programs, or groups of related uses associated with the proposed action. The following CDs were included in the public review draft of the CCP/EA and presented as approved in this document.

**Table B-1. Summary of Compatibility Determinations.**

| Refuge Use | Page | Compatible? | Year Due for Reevaluation |
|---|---|---|---|
| Wildlife Observation, Interpretation, and Photography | B-5 | yes | 2026 |
| Environmental Education (EE) | B-11 | yes | 2026 |
| Research, Scientific Collecting, and Surveys | B-17 | yes | 2021 |

### B.1.2 Compatibility – Legal and Historical Context

Compatibility is a tool refuge managers use to ensure that recreational and other uses do not interfere with wildlife conservation, the primary focus of refuges. Compatibility is not new to the Refuge System and dates back to 1918 as a concept. As policy, it has been used since 1962. The Refuge Recreation Act of 1962 directed the Secretary of the Interior to allow only those public uses of Refuge lands that were "compatible with the primary purposes for which the area was established."

Legally, Refuges are closed to all public uses until officially opened. Regulations require that adequate funds be available for administration and protection of refuges before opening them to any public uses. However, wildlife-dependent recreational uses (hunting, fishing, wildlife observation and photography, EE and interpretation) are to receive enhanced consideration and cannot be rejected simply for lack of funding resources unless the refuge has made a concerted effort to seek out funds

from all potential partners. Once found compatible, wildlife-dependent recreational uses are deemed the priority public uses at the refuge. If a proposed use is found not compatible, the refuge manager is legally precluded from approving it. Economic uses that are conducted by or authorized by the refuge also require CDs.

Under compatibility policy, uses are defined as recreational, economic/commercial, or management use of a refuge by the public or a non-Refuge System entity. Uses generally providing an economic return (even if conducted for the purposes of habitat management) are also subject to CDs. The Service does not prepare CDs for uses when the Service does not have jurisdiction. For example, the Service may have limited jurisdiction over Refuge areas where property rights are vested by others; where legally binding agreements exist; or where there are treaty rights held by tribes. In addition, aircraft overflights, emergency actions, some activities on navigable waters, and activities by other Federal agencies on "overlay Refuges" are exempt from the compatibility review process.

New compatibility regulations were adopted by the Service in October 2000. The regulations require that a use must be compatible with both the Refuge System mission and the purpose(s) of the individual Refuge. This standard helps to ensure consistency in application across the Refuge System. The Administration Act also requires that CDs be in writing and that the public have an opportunity to comment on most use evaluations.

The Refuge System mission emphasizes that the needs of fish, wildlife, and plants must be of primary consideration. The Improvement Act defined a compatible use as one that ". . . in the sound professional judgment of the Director, will not materially interfere with or detract from the fulfillment of the mission of the System or the purposes of the Refuge." Sound professional judgment is defined under the Improvement Act as ". . . a finding, determination, or decision, that is consistent with principles of sound fish and wildlife management and administration, available science and resources . . ." Compatibility for wildlife-dependent uses may depend on the level or extent of a use.

Court interpretations of the compatibility standard have found that compatibility is a biological standard and cannot be used to balance or weigh economic, political, or recreational interests against the primary purpose of the refuge (*Defenders of Wildlife* v. *Andrus*).

The Service recognizes that CDs are complex. For this reason, refuge managers are required to consider "principles of sound fish and wildlife management" and "best available science" in making these determinations (House of Representatives Report 105-106). Evaluations of the existing uses on the James Campbell NWR are based on the professional judgment of Refuge and planning personnel including observations of Refuge uses and reviews of relevant scientific literature.

## B.1.3 Appropriate Use Findings

The Appropriate Refuge Uses Policy outlines the process that the Service uses to determine when general public uses on refuges may be considered. Priority public uses previously defined as wildlife-dependent uses (hunting, fishing, wildlife observation and photography, and EE and interpretation) under the Improvement Act are generally exempt from appropriate use review. Other exempt uses include situations where the Service does not have adequate jurisdiction to control the activity and refuge management activities. In essence, the Appropriate Use policy, 603 FW 1 (2006), provides refuge managers with a consistent procedure to first screen and then document decisions concerning

a public use. When a use is determined to be appropriate, a refuge manager must then decide if the use is compatible before allowing it on a refuge. The policy also requires review of existing public uses. During the CCP process, the refuge manager evaluated all existing and proposed Refuge uses at James Campbell NWR using the following guidelines and criteria as outlined in the appropriate use policy:

- Do we have jurisdiction over the use?
- Does the use comply with applicable laws and regulations (Federal, State, tribal and local)?
- Is the use consistent with applicable Executive orders and Department and Service policies?
- Is the use consistent with public safety?
- Is the use consistent with goals and objectives in an approved management plan or other document?
- Has an earlier documented analysis not denied the use or is this the first the use has been proposed?
- Is the use manageable within available budget and staff?
- Will this be manageable in the future within existing resources?
- Does the use contribute to the public‟s understanding and appreciation of the refuge‟s natural or cultural resources, or is the use beneficial to the refuge‟s natural or cultural resources?
- Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality, compatible, wildlife dependent recreation into the future?

Using this process and these criteria, and as documented on the following pages, the Refuge Manager determined the following uses are appropriate, and directed that a CD be completed for these uses: research, scientific collecting, and surveys. The Refuge Manager determined the following uses are not appropriate: sea asparagus farming and private aircraft operations.

**Table B-2. Summary of Appropriate Use Findings.**

| Refuge Use | Page | Appropriate? |
|---|---|---|
| Research, Scientific Collecting, and Surveys | B-24 | yes |
| Commercial Operation, Sea Asparagus Farming | B-27 | no |
| Private Aircraft Operations | B-31 | no |

## B.1.4 References

Compatibility regulations, adopted by the Service in October 2000: http://Refuges.fws.gov/policymakers/nwrpolicies.html

*Defenders of Wildlife* v. *Andrus* (Ruby Lake Refuge I). 11 Envtl. Rptr. Case 2098 (D.D.C. 1978), p. 873.

Fish and Wildlife Service. 2010. James Campbell National Wildlife Refuge: *Draft Comprehensive Conservation Plan and Environmental Assessment.* 109 p. + Appendices

House of Representatives Report 105-106 (on Improvement Act): http://refuges.fws.gov/policyMakers/mandates/HR1420/part1.html

## B.2 Compatibility Determination for Wildlife Observation, Interpretation, and Photography

**Refuge Name(s):** James Campbell National Wildlife Refuge

**County and State:** Honolulu County, Hawai„i

**Establishing and Acquisition Authority(ies):**

James Campbell NWR was established in 1976 under the authority of the:

- Fish and Wildlife Coordination Act of 1956, as amended (16 U.S.C. 742a – 742j)
- Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544)
- James Campbell National Wildlife Refuge Expansion Act of 2005, Pub. Law 109-225 (16 U.S.C. 668dd)

**Refuge Purpose(s):**

"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...".

**National Wildlife Refuge System Mission:**

"The mission of the National Wildlife Refuge System (Refuge System) is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (Administration Act).

**Description of Use(s):**

The National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997 identifies wildlife observation, interpretation, and photography (WO/I/P) among wildlife-dependent public uses which, when compatible with the purpose(s) of the refuge, are priority public uses and receive special consideration in planning for and management of the Refuge System. This CD addresses the Wildlife Observation/Interpretation/Photography program, as well as modest new increases and opportunities being provided on both existing refuge lands and the expansion lands planned for addition to the Refuge, once acquired. These activities are proposed to continue while acquisition of new Refuge lands is completed and a subsequent Visitor Services Plan (VSP) is developed (within 5 years of final land acquisition). This VSP will identify and evaluate a range of alternatives and options for new refuge visitor facilities and uses all across the expanded Refuge lands including the location of roads, parking area, overlooks, trails and possible construction of a visitor center. An updated CD, if needed, will be prepared in conjunction with this plan and all activities identified in this CD are subject to review and change at that time.

Interpretation is the communication of information about, or the explanation of, the nature, origin, and purpose of historical, natural, or cultural resources, objects, sites and phenomena using various methods. The docent-guided tour program provides interpretive information about the identity and

life histories of both endangered and migratory birds viewed along the tour route. Scheduled from October 15-February 28 of each year, the tours last about 90 minutes and follow a designated route along dikes around a portion of the Refuge wetlands.

Wildlife observation, interpretation, and photography are considered together in this CD because they are considered to be wildlife-dependent, nonconsumptive uses and many elements of these programs are similar. Activities would be allowed as described below:

- On designated portions of Ki„i Unit at designated dates, times and routes; and
- During daylight hours on the Refuge coastal area within the beach transit corridor only.

The Ki„i Unit is closed to general public entry and use and the only access to the unit is through a coded automatic gate. Under this CD the current docent guided tour program would continue to be conducted on Thursdays and Saturdays providing WO/I/P opportunities up to 42 days per season for approximately 820 total visitors. Trained docents provide information about the identity and life histories of both endangered and migratory birds viewed along the tour route. In addition to these docent-guided tours, new individual self-guided tours will be initiated during this same season to allow additional visitors in small parties (1-5 of the same party) to view and photograph wildlife at their own pace, not in a group. This will be of particular benefit to persons wishing to photograph wildlife who will not have to continually move to stay with a larger group, as in the guided tours. While providing limited new WO/I/P opportunities this new self-guided program is small in scale by necessity due to the extremely small size of the Ki„i Unit, very limited public access and facilities, the need to limit disturbance to wildlife and prevent scheduling conflicts with both guided tours and EE tours that occur in this same area during this same season. Both guided and self-guided tours will be conducted under a reservation system.

Except when and where closed for protection of individual „īlio-holo-i- ka-uaua and/or honu, WO/I/P use will be permitted in the State-defined "beach access corridor" (Hawai„i Revised Statutes §115-5) by public access routes at either end of the Refuge boundary. The designated open portion of the Refuge extends to the highest reach of the highest wash of the waves, up to the first line of naupaka and tree heliotrope vegetation that is well established all along the dunes. Refuge lands mauka (inland) of this line will remain closed to the public.

**Availability of Resources:**

| Category and Itemization | One-time $ | Annual $/yr |
|---|---|---|
| Administration and management: | $0 | $800 |
| Maintenance: | $0 | $1,400 |
| Monitoring costs: | $0 | $3,600 |
| Special equipment, facilities, or improvements: | $2,000 | $1,800 |
| Offsetting revenues: | $0 | $0 |

The Refuge has sufficient budget and staff to manage this use.

**Anticipated Impacts of the Use(s):**

**Short-term impacts:**
Ki„i Unit: The continuation of the current guided tours on the Ki„i Unit will not produce any new short-term impacts. The current program has been in place for many years and through observation the impacts to wildlife are well known and understood. The primary short-term impact is to individual wildlife as birds may flush, swim away or seek cover and hide in vegetation as tour groups pass by. These impacts are minimized by the tours being limited by following designated times, routes and numbers of participants. The additional new self-guided tours will result in only a small increase in activity over the current level of guided tours and EE programs combined that occur in generally the same area and during the same season. This additional activity will result in only a very small increase in the impacts already described, i.e., temporary disturbance to wildlife.

Refuge coastal dunes: Currently a number of people access the coastal area by entering along the shoreline at either end of the property (Refuge expansion land) or by crossing over the adjacent private land (James Campbell Company) by either permission or trespassing. The public transit corridor along the shoreline is indistinguishable for most users from the adjacent private property due to the similarity in appearance (beach), immediate close proximity and lack of any identifiers such as signs or fences. Consequently current uses on the shoreline occur without regard to property boundaries. Under this CD, once acquired, visitor uses described as WO/I/P will continue and be allowed on the Refuge portion of the coastal area up to the naupaka line of vegetation. The level of use will actually decline in the short-term as public access along the shoreline will not change and should remain about the same but private access across James Campbell Company land, once acquired by the Refuge, will be not be allowed.

The primary short-term impacts from this use are the possible disturbance to wildlife, primarily „īlio-holo-i- ka-uaua and honu that may haul out on shore. Coordination and cooperation with wildlife monitoring groups should reduce disturbance to these individual animals due to closer monitoring. A particular concern is nighttime activity which can distract or disorient wildlife, particularly nesting turtles (which come ashore at night) or nesting and fledgling seabirds. To minimize the risk of this impact occurring, access to the Refuge portion of the shoreline will be open to public use such as WO/I/P only during daylight hours (½-hour before sunrise to ½-hour after sunset).

**Long-term impacts:**
Ki,,i Unit - As additional lands are acquired and added to the Refuge, new opportunities for WO/I/P will become available. These new opportunities will be identified and evaluated in the preparation of a VSP. As new opportunities and facilities necessary to conduct these uses are developed the existing uses on the Ki,,i Unit will be re-evaluated and likely phased out or reduced. Therefore long-term impacts (occasional temporary disturbance to wildlife) of the use described in this CD are expected to diminish over time and will be re-evaluated for uses proposed under any new CD in conjunction with the preparation of the VSP.

Refuge coastal dunes - Visitor use in this habitat is not expected to increase and should decrease slightly due to stricter control of access. This could result in a slight decrease of impacts over time. A significant long-term concern will be the presence of nesting seabirds. A few seabirds, primarily wedge-tailed shearwaters, attempt to nest along the coast each year, but have been generally unsuccessful due to the uncontrolled presence of nonnative predators. To aid in protection of seabirds, a predator control program will be implemented along the Refuge coastal dunes, and it is anticipated that a variety of seabird species will once again be able to successfully nest in this area. Both seabird and human activity along the shoreline will need to be monitored to determine the level of disturbance that may be occurring to nesting seabirds from Refuge activities, including WO/I/P. As described below under stipulations, the Refuge Manager has the authority to close areas open to public uses if the need arises to protect wildlife.

Cumulative impacts: The level and type of use from activities described in this CD is not expected to result in any significant cumulative impacts.

**Public Review and Comment:**

Public review and comments on this CD were solicited in conjunction with the release of the James Campbell National Wildlife Refuge Draft CCP/EA (2011), in order to comply with NEPA and Service policy. This CD was released as an integral part of the CCP and received the same level of public review and comments as the CCP, in accordance with Service planning policy.

**Determination: (check one below)**

**___ Use is Not Compatible**
**_✓_ Use is Compatible With Following Stipulations**

**Stipulations Necessary to Ensure Compatibility:**

**Ki‘i Unit** - Activity (both guided and self-guided tours) is allowed only during the non-nesting season of ae,,o to prevent disturbance to this sensitive species (October 15-February 28).

During this seasonal use, designated times, areas and routes established by the Refuge Manager for both guided and self-guided tours will be used to further minimize disturbance to all wildlife and prevent conflicts with Refuge management actions being conducted by the staff. Tour group sizes are limited to 20 for docent-guided tours and 5 for self-guided tours, limited to 1 tour per day. Self-guided tours will be allowed only during regular business hours Monday-Friday. Due to the closed nature of the Refuge it is not desirable or advisable to have persons on self-guided tours enter

and be present on the Refuge when Refuge staff is not present. Docent-guided tours are only conducted on Thursday and Saturday.

Self-guided tours would be required to register for designated areas and hear or read orientation materials regarding appropriate wildlife viewing behavior and Refuge regulations to protect wildlife.

**Refuge coastal area** - The Refuge Manager would still maintain the authority to close any portion of the Refuge-owned and -managed shoreline to the public for any period of time (temporarily, seasonally or year-round) to protect wildlife including „Ilio-holo-i-ka-uaua, honu, seabirds or native plants (Code of Federal Regulations; 50 CFR 25.21(e) and 25.31). Closing is generally accomplished by signing and/or fencing. Access along the shore is pedestrian only, no entry by horseback or motorized vehicles permitted.

Activities would be restricted to daylight hours only (sunrise to sunset).

**Justification:**

Wildlife observation, interpretation, and photography are identified as priority public uses of the National Wildlife Refuge System and are identified in the goals of the James Campbell NWR CCP; therefore a program which includes these uses fulfills a part of the Refuge System mission and Refuge goals.

The current WO/I/P program on the Ki„i Unit has been in place many years. Even in combination with the EE program which occurs in the same area and during the same season, the disturbance to wildlife is considered to be minimal. The small increase in visitor numbers planned by adding small (up to 5) self-guided tours during this same timeframe and in the same area of the Refuge will not significantly change or increase the level of disturbance to wildlife.

Shoreline use will continue similar to what is occurring now (pre-acquisition) but with much improved monitoring, closed night-time use and authority to close Refuge owned/managed portions of the shoreline (under 50 CFR 25.21(e)) if it becomes necessary to prevent disturbance and protect wildlife. The land acquisition process is ongoing and recently or soon-to-be acquired lands will significantly change the size and nature of the Refuge. Once acquisition of these new lands is completed, it will take careful consideration and planning to determine the most suitable and practical sites for new public roads, parking areas, trails, areas both open or closed to the public, and special regulations necessary to protect wildlife, fragile natural and cultural resources, and the visiting public. An updated CD for WO/I/P uses may be prepared at that time which will incorporate new facilities and stipulations identified in the VSP. All uses and stipulations identified in this CD will be subject to review and change at that time.

Although WO/I/P activities can result in disturbance to wildlife, disturbance will be intermittent and short-term. There is more than adequate undisturbed habitat available to Refuge wildlife for escape and cover. It is anticipated that wildlife populations will find sufficient food resources and resting places such that their abundance and use of the Refuge will not be measurably lessened from these activities. The relatively limited number of individuals expected to be adversely affected due to this Refuge use will not cause wildlife populations to materially decline, the physiological condition and production of any plant or animal species will not be impaired, and their overall welfare will not be

negatively impacted. Thus allowing WO/I/P on the Refuge will not materially interfere with or detract from the fulfillment of the Refuge System mission or the purposes of this Refuge.

**Mandatory Reevaluation Date:** (provide month and year for "allowed" uses only)

June 2026 Mandatory 15-year reevaluation date (for wildlife-dependent public uses)

_____ Mandatory 10-year reevaluation date (for all uses other than wildlife-dependent public uses)

**NEPA Compliance for Refuge Use Decision:** (check one below)

___ Categorical Exclusion without Environmental Action Statement

____ Categorical Exclusion and Environmental Action Statement

_ __ Environmental Assessment and Finding of No Significant Impact

___ Environmental Impact Statement and Record of Decision

**Signatures:**

The Compatibility Determination for Wildlife Observation, Interpretation, and Photography is compatible with stipulations.

Prepared by:

Refuge Planner,
Hawaiian and Pacific Islands NWRC

_____ _____
(Signature) (Date)

Project Leader,
O,,ahu National Wildlife Refuge Complex
Approval:

_____ _____
(Signature) (Date)

**Concurrence:**

Project Leader,
Hawaiian and Pacific Islands NWRC

_____ _____
(Signature) (Date)

Regional Chief,
National Wildlife Refuge System:

_____ _____
(Signature) (Date)

## B.3 Compatibility Determination for Environmental Education

**Refuge Name(s):** **James Campbell National Wildlife Refuge**

**County and State:** Honolulu County, Hawai„i

**Establishing and Acquisition Authority(ies):**

James Campbell NWR was established in 1976 under the authority of the:

- Fish and Wildlife Coordination Act of 1956, as amended (16 U.S.C. 742a – 742j)
- Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544)
- James Campbell National Wildlife Refuge Expansion Act of 2005, Pub. Law 109-225 (16 U.S.C. 668dd)

**Refuge Purpose(s):**

"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...".

**National Wildlife Refuge System Mission:**

"The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (Administration Act).

**Description of Use(s):**

Environmental education (EE) is defined as a wildlife-dependent recreational use under the Improvement Act. Environmental education consists of educational activities conducted by Refuge staff, volunteers, partners and teachers. This CD addresses the current EE program which is proposed to continue while acquisition of new Refuge lands is completed and a subsequent Visitor Services Plan (VSP) is developed. This plan will identify and evaluate a wide range of new EE opportunities associated with the expanded Refuge, including the possible construction of a dedicated EE facility.

Currently, the EE program on the Refuge serves a range of 900-1500 students annually, depending on the level of participation by individual schools. The program focuses on the management and protection of endangered waterbirds, wetlands, and other native wildlife. The entire program is conducted under a Special Use Permit (SUP) issued to the non-profit organization Papahana Kuaola, which organizes and conducts the programs. As the Refuge currently has limited staff available for EE, the program could not be conducted without this cooperation/participation of Papahana Kuaola or other non-profit partner. Due to a lack of suitable and safe access (roads and parking) and other facilities on other portions of the Refuge, all EE activities currently take place on the Ki„i Unit where limited access and facilities are available.

During the interim period after land acquisition is complete and while the VSP is being developed, most EE activities will continue to be conducted on the Ki„i Unit. Additional EE activities may be conducted on new Refuge lands but may be limited by road conditions or lack of other facilities and conducted on a case by case basis under a SUP or by Refuge staff, if available.

Environmental education activities on the Ki„i Unit will continue during the non-nesting season of ae‟o (October 15-February 28) to minimize disturbance to this sensitive species. Programs are conducted Monday, Wednesdays, or Fridays with a maximum of 60 students being allowed along with teachers and chaperones and programs are conducted from 11:30 a.m.-1:30p.m. Under the current EE program structure approximately 55 days per year (depending on holidays) are allocated for EE programs (M,W,F, October 15-February 28). While the actual number of programs conducted varies from year to year, many dates currently identified for EE programs are not utilized. Therefore, under the current program structure up to approximately 3,300 students could be accommodated each EE season.

This EE program supports the environmental/wetlands curriculum being provided by schools to grades 3-5. After participating in classroom learning about Hawaiian wetlands and birds, the field trip to the Refuge is the first opportunity for most students to visit a refuge, see endangered Hawaiian waterbirds, and learn first-hand about efforts to manage and protect these species and their habitats.

**Availability of Resources:**

| Category and Itemization | One-time $ | Annual $/yr |
|---|---|---|
| Administration and management: | $0 | $1,000 |
| Maintenance: | $0 | $900 |
| Materials: | $0 | $1,000 |
| Special equipment, facilities, or improvements: | $0 | $1,000 |
| Offsetting revenues: | $0 | $ |

Minimal costs of EE will be covered by Refuge visitor services funding provided in the annual Refuge budget.

**Anticipated Impacts of the Use(s):**

**Short-term impacts:** Under the current program, the number of school groups and students visiting the Refuge may vary from year to year but this variation is already considered in the guidelines and structure established for the program. The primary impacts come from temporary disturbance to individual animals (primarily birds) due to the presence and activity of the students as they are guided around the wetlands. The animals may flush, swim away or seek cover and hide in vegetation. These impacts are mitigated by restricting the days, times, routes and locations that EE activities take place. This allows the students to participate in the EE experience while causing temporary disturbance over the smallest area and to the fewest birds. This program has been in place many years and while, as noted, it does have an effect on individual birds it has not had a noticeable impact on bird populations using the Refuge.

**Long-term impacts:** The current, ongoing EE program covered by this CD will not cause any significant long-term impacts. With the recently acquired or pending acquisition of Refuge expansion lands many new possibilities and opportunities for EE programs and facilities will be available. To identify and evaluate these new possibilities a VSP will be developed within 5 years of the final land acquisition. This plan will identify and evaluate major new features and facilities, such as roads, parking area and trails that will be developed and used to support and implement an expanded EE program, as well as other visitor use programs. It is anticipated that this plan will consider and develop EE opportunities and facilities on other areas of the refuge shifting EE activities away from the Ki„i Unit in the long-term so that the current low level of disturbance associated with the current EE program on the Ki„i Unit will be reduced.

Cumulative impacts: This EE program has been conducted in the current manner for many years and no cumulative impacts to wildlife resources on the refuge have been observed or are anticipated. Although the potential of the EE program could bring 6,000 students to the Refuge, the limitation to 60 students per day retains the current impact regime. Although these activities can result in disturbance to wildlife, disturbance will be intermittent and short-term. There is more than adequate undisturbed habitat available to Refuge wildlife for escape and cover. It is anticipated that wildlife populations will find sufficient food resources and resting places such that their abundance and use of the Refuge will not be measurably lessened from these activities. The relatively limited number of individuals expected to be adversely affected due to this Refuge use will not cause wildlife populations to materially decline, the physiological condition and production of any plant or animal species will not be impaired, and their overall welfare will not be negatively impacted. Thus allowing EE on the Refuge will not materially interfere with or detract from the fulfillment of the Refuge System mission or the purposes of this Refuge.

**Public Review and Comment:**

Public review and comments on this CD were solicited in conjunction with the release of the James Campbell National Wildlife Refuge Draft CCP/EA (2011), in order to comply with the National Environmental Policy Act and Service policy. This CD was released as an integral part of the CCP and received the same level of public review and comments as the CCP, in accordance with Service planning policy.

**Determination:** (check one below)

___ Use is Not Compatible

_✓_ Use is Compatible with Following Stipulations

**Stipulations Necessary to Ensure Compatibility:**

All access to the Refuge for EE activities not directly supervised by Service personnel is regulated by issuance of annual SUPs. The use of SUPs allows the Refuge Manager to continually adjust the activity to any significant new or changing conditions on the Refuge, as needed. However, the current programs are well established and such changes have been infrequent.

To prevent disturbance to sensitive ae,,o during their nesting season, regularly scheduled EE activities will occur during the non-nesting season (October 15-February 28) and are limited to designated times, locations and routes of travel to reduce overall disturbance to wildlife. Group size is limited to a maximum of 60 students.

The current EE program on the Ki,,i Unit has been in place many years. Even in combination with the wildlife tour program which occurs in the same area and during the same season, the disturbance to wildlife is considered to be minimal and at an acceptable level.

**Justification:**
Compatible EE is a priority wildlife-dependent public use of the Refuge System and is a goal in the James Campbell NWR CCP; therefore, implementation of the program fulfills a part of the Refuge System mission and Refuge goals. The program is intended to foster a better understanding of the Refuge and in turn build a public that is more knowledgeable about and supportive of natural resource issues and needs. Minimal impacts are incurred by implementation of existing EE programs or expected by modest increases as proposed in the CCP and as long as the stipulations to ensure compatibility are followed, the benefits received through public education, participation, and involvement outweigh the minimal impacts.

Although EE activities can result in disturbance to wildlife, disturbance will be intermittent and short-term. There is more than adequate undisturbed habitat available to Refuge wildlife for escape and cover. It is anticipated that wildlife populations will find sufficient food resources and resting places such that their abundance and use of the Refuge will not be measurably lessened from these activities. The relatively limited number of individuals expected to be adversely affected due to this Refuge use will not cause wildlife populations to materially decline, the physiological condition and production of any plant or animal species will not be impaired, and their overall welfare will not be negatively impacted. Additionally, it is anticipated that monitoring, as needed, will prevent unacceptable or irreversible impacts to fish, wildlife, plants, and their habitats. Thus conducting the EE program will not materially interfere with or detract from the fulfillment of the Refuge System mission or the purposes of this Refuge.

**Mandatory Reevaluation Date:** (provide month and year for "allowed" uses only)

June 2026 Mandatory 15-year reevaluation date (for wildlife-dependent public uses)
_____ Mandatory 10-year reevaluation date (for uses other than wildlife-dependent public uses)

**NEPA Compliance for Refuge Use Decision:** (check one below)

____ Categorical Exclusion without Environmental Action Statement
____ Categorical Exclusion and Environmental Action Statement
____ Environmental Assessment and Finding of No Significant Impact
____ Environmental Impact Statement and Record of Decision

**Signatures:**

The Compatibility Determination for Environmental Education is compatible with stipulations.

Prepared by:

Refuge Planner,
Hawaiian and Pacific Islands NWRC

_____ _____
(Signature) (Date)

Project Leader,
O,,ahu National Wildlife Refuge Complex
Approval:

_____ _____
(Signature) (Date)

**Concurrence:**

Project Leader,
Hawaiian and Pacific Islands NWRC

_____ _____
(Signature) (Date)

Regional Chief,
National Wildlife Refuge System:

_____ _____
(Signature) (Date)

## B.4 Compatibility Determination for Research, Scientific Collecting, and Surveys

**CD Terminology:**

*Research*: Planned, organized, and systematic investigation of a scientific nature.
*Scientific collecting*: Gathering of refuge natural resources or cultural artifacts for scientific purposes.
*Surveys*: Scientific inventory or monitoring.

**Refuge Name(s): James Campbell National Wildlife Refuge**

**County and State:** Honolulu County, Hawai„i

**Establishing and Acquisition Authority(ies):**

James Campbell NWR was established in 1976 under the authority of the:

- Fish and Wildlife Coordination Act of 1956, as amended (16 U.S.C. 742a – 742j)
- Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544)
- James Campbell National Wildlife Refuge Expansion Act of 2005, Pub. Law 109-225 (16 U.S.C. 668dd)

**Refuge Purpose(s):**

"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...".

**National Wildlife Refuge System Mission:**

"The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (Administration Act).

**Description of Use(s):**

The Refuge staff receives periodic requests from non-Service entities (e.g., universities, State agencies, other Federal agencies, nongovernmental organizations) to conduct research, scientific collecting, and surveys on Refuge lands. These project requests can involve a wide range of natural and cultural resources as well as public use management issues, including basic absence/presence surveys, collection of new species for identification, habitat use and life-history requirements for specific species/species groups, practical methods for habitat restoration, extent and severity of environmental contaminants, techniques to control or eradicate pest species, effects of climate change on environmental conditions and associated habitat/wildlife response, identification and analyses of paleontological specimens, wilderness character, modeling wildlife populations, and assessing response of habitat/wildlife to disturbance from public uses. Projects may be species-

specific, Refuge-specific, or evaluate the relative contribution of the Refuge lands to larger landscapes (e.g., ecoregion, region, flyway, national, international) issues and trends.

The Service"s research and management and Appropriate Refuge Uses (603 FW1.10D(4)) policies indicate priority for scientific investigatory studies that contribute to the enhancement, protection, use, preservation, and management of native wildlife populations and their habitat as well as their natural diversity. Projects that contribute to refuge-specific needs for resource and/or wilderness management goals and objectives, where applicable, would be given a higher priority over other requests.

**Availability of Resources:**

Refuge staff responsibilities for projects by non-Service entities will primarily be limited to the following: review of proposals, prepare special use permits (SUP) and other compliance documents (e.g., Section 7 of the ESA, Section 106 of the National Historic Preservation Act), and monitor project implementation to ensure that impacts and conflicts remain within acceptable levels (compatibility) over time. Additional administrative support, logistical and operational support may also be provided depending on each specific request. Estimated costs for one-time (e.g., prepare SUP) and annually recurring tasks by Refuge staff and other Service employees will be determined for each project. Sufficient funding in the general operating budget of the Refuge must be available to cover expenses for these projects. The terms and conditions for funding and staff support necessary to administer each project on the Refuge will be clearly stated in the SUP(s).

The Refuge has the following staffing and funding to administratively support and monitor research that is currently taking place on Refuge lands (see table below). Any substantial increase in the number of projects would create a need for additional resources to oversee the administration and monitoring of the investigators and their projects. Any substantial additional costs above those itemized below may result in finding a project not compatible unless expenses are offset by the investigator(s), sponsoring agency, or organization.

| Category and Itemization | One-time $ | Annual $/yr |
|---|---|---|
| Administration and management | $0 | $4,200 |
| Maintenance | $0 | $0 |
| Monitoring | $0 | $3,100 |
| Special equipment, facilities, or improvement | $0 | $0 |
| Offsetting revenues | $0 | $0 |

Itemized costs in the table above are current estimates calculated using 7% of the base cost for a GS-12 Refuge Biologist/Refuge Manager and a 3% cost of a GS-13 Refuge Manager.

**Anticipated Impacts of the Use:**

Use of the Refuge(s) to conduct research, scientific collecting, and surveys will generally provide information that would benefit fish, wildlife, plants, and their habitats. Scientific findings gained through these projects provide important information regarding life-history needs of species and species groups as well as identify or refine management actions to achieve resource management

objectives in Refuge management plans (especially CCPs). Reducing uncertainty regarding wildlife and habitat responses to Refuge management actions in order to achieve desired outcomes reflected in resource management objectives is essential for adaptive management in accordance with 522 DM 1.

If project methods impact or conflict with Refuge-specific resources, priority wildlife-dependent public uses, other high-priority research, and Refuge habitat and wildlife management programs, then it must be clearly demonstrated that the scientific findings will contribute to resource management and that the project cannot be conducted off-Refuge for the project to be compatible. The investigator(s) must identify methods/strategies in advance required to eliminate or minimize the potential impact(s) and conflict(s). If unacceptable impacts cannot be avoided, then the project will not be compatible.

Impacts would be project- and site-specific, where they will vary depending upon nature and scope of the field work. Data collection techniques will generally have minimal animal mortality or disturbance, habitat destruction, no introduction of contaminants, or no introduction of nonnative species. In contrast, projects involving the collection of biotic samples (plants or animals) or requiring intensive ground-based data or sample collection will have short-term impacts. To reduce impacts, the minimum number of samples (e.g., water, soils, vegetative litter, plants, macroinvertebrates, and vertebrates) will be collected for identification and/or experimentation and statistical analysis. Where possible, researchers would coordinate and share collections to reduce sampling needed for multiple projects.

Investigator(s) obtaining required State and Federal collecting permits will also ensure minimal impacts to fish, wildlife, plants, and their habitats. If, after incorporating the above strategies, the project results in long-term or cumulative effects, it will not be deemed compatible. A Section 7 consultation under the ESA will be required for activities that may affect a federally listed species and/or critical habitat. Only projects that have no effect or will result in not likely to adversely affect determinations will be considered compatible.

Spread of pest plants and/or pathogens is possible from ground disturbance and/or transportation of project equipment and personnel, but it will be minimized or eliminated by requiring proper cleaning of investigator equipment and clothing as well as quarantine methods, where necessary. If after all practical measures are taken, an unacceptable spread of pest species is anticipated to occur, then the project will be found not compatible without a restoration or mitigation plan.

Localized and temporary effects may occur from vegetation trampling, collecting of soil and plant samples, or trapping and handling of wildlife. Impacts may also occur from infrastructure necessary to support a projects (e.g., permanent transects or plot markers, exclosure devices, monitoring equipment, solar panels to power unattended monitoring equipment). Some level of disturbance is expected with these projects, especially if investigator(s) enter areas closed to the public and collect samples or handle wildlife. However, wildlife disturbance (including altered behavior) will usually be localized and temporary in nature. Where long-term or cumulative unacceptable effects cannot be avoided, the project will not be found compatible. Project proposals will be reviewed by Refuge staff and others, as needed, to assess the potential impacts (short-term, long-term, and cumulative) relative to benefits of the investigation to Refuge management issues and understanding of natural systems.

At least 6 months before initiation of field work (unless an exception is made by prior approval of the Refuge Manager), project investigator(s) must submit a detailed proposal. Project proposals will be reviewed by Refuge staff and others, as needed, to assess the potential impacts (short-term, long-term, and cumulative) relative to benefits of the investigation to Refuge management issues and understanding of natural systems. This assessment will form the primary basis for allowing or denying a specific project. Projects that result in unacceptable Refuge impacts will not be found compatible. If allowed and found compatible after approval, all projects also will be assessed during implementation to ensure impacts and conflicts remain within acceptable levels.

If the proposal is approved, then the Refuge Manager will issue a SUP(s) with required stipulations (terms and conditions) of the project to avoid and/or minimize potential impacts to Refuge resources as well as conflicts with other public-use activities and Refuge field management operations. After approval, projects also are monitored during implementation to ensure impacts and conflicts remain within acceptable levels based upon documented stipulations.

Projects that are not covered by the CCP will require additional NEPA documentation.

**Public Review and Comment:**

Public review and comments on this CD were solicited in conjunction with the release of the James Campbell National Wildlife Refuge Draft CCP/EA (2011), in order to comply with the National Environmental Policy Act and Service policy. This CD was released as an integral part of the CCP and received the same level of public review and comments as the CCP, in accordance with Service planning policy.

**Determination:** (check one below)

____ The use is not compatible.

_✓_ The use is compatible with the following stipulations.

**Stipulations Necessary to Ensure Compatibility:**

Each project will require an SUP. Annual or other short-term SUPs are preferred; however, some permits will be a longer period, if needed, to allow completion of the project. All SUPs will have a definite termination date. Permit renewals will be subject to Refuge Manager review and approval based on timely submission of and content in progress reports, compliance with SUP stipulations, and required permits. Other stipulations and provisions would include the following:

- Projects will adhere to scientifically defensible protocols for data collection, where available and applicable.
- Investigators must possess appropriate and comply with conditions of State and Federal permits for their projects.
- If unacceptable impacts to natural resources or conflicts arise or are documented by the Refuge staff, then the Refuge Manager can suspend, modify conditions of, or terminate an on-going project already permitted by SUP(s) on a Refuge.
- Progress reports are required at least annually for multiple-year projects.
- Final reports are due 1 year after completion of the project unless negotiated otherwise with the Refuge Manager.

- Continuation of existing projects will require approval by the Refuge Manager.
- The Refuge staff will be given the opportunity to review draft manuscript(s) from the project before being submitted to a scientific journal(s) for consideration of publication.
- The Refuge staff will be provided with copies (including, but not limited to: reprints, videos, and CDs) of all publications resulting from a Refuge project.
- The Refuge staff will be provided with copies of raw data (preferably electronic database format) at the conclusion of the project.
- Upon completion of the project or annually, all equipment and markers (unless required for long-term projects), must be removed and sites must restored to the Refuge Manager"s satisfaction. Conditions for clean-up and removal of equipment and physical markers will be stipulated in the SUP(s).
- All samples collected on Refuge lands are the property of the Service even while in the possession of the investigator(s). Any future work with previously collected samples not clearly identified in the project proposal will require submission of a subsequent proposal for review and approval. In addition, a new SUP will be required for additional project work. For samples or specimens to be stored at other facilities (e.g., museums), a memorandum of understanding will be necessary.
- Sampling equipment as well as investigator(s) clothing and vehicles (e.g., ATV, boats) will be thoroughly cleaned (free of dirt and plant material) before being allowed for use on Refuge lands and/or waters to prevent the introduction and/or spread of pests.
- The Service, specific Refuge unit, names of Refuge staff and other Service personnel who supported or contributed to the project will be appropriately cited and acknowledged in all written and oral presentations resulting from projects on Refuge lands.
- At any time, Refuge staff may accompany investigator(s) in the field.
- Investigator(s) and support staff will follow all Refuge-specific regulations that specify access and travel on the Refuge.

**Justification:**

Research, scientific collecting, and surveys on Refuge lands are inherently valuable to the Service because they will expand scientific information available for resource management decisions. In addition, only projects that directly or indirectly contribute to the enhancement, protection, use, preservation, and management of Refuge wildlife populations and their habitats generally will be authorized on Refuge lands. In many cases, if it were not for the Refuge staff providing access to Refuge lands and waters along with some support, the research project would likely not occur and less scientific information would be available to the Service to aid in managing and conserving resources. By allowing the use to occur under the stipulations described above, it is anticipated that wildlife species that could be disturbed during the use would find sufficient food resources and resting places so their abundance and use will not be measurably lessened on the Refuge. Additionally, it is anticipated that monitoring, as needed, will prevent unacceptable or irreversible impacts to fish, wildlife, plants, and their habitats. The combination of stipulations identified above and conditions included in any SUP(s) will ensure that proposed projects contribute to the enhancement, protection, conservation, and management of native wildlife populations and their habitats on the Refuge. As a result, these projects will not materially interfere with or detract from fulfilling Refuge purpose(s); contributing to the mission of the Service and Refuge System; and maintaining the biological integrity, diversity, and environmental health of the Refuge.

**Mandatory Re-evaluation Date:** (provide month and year for "allowed" uses only)

___ Mandatory 15-year re-evaluation date (wildlife-dependent public uses)

June 2021Mandatory 10-year re-evaluation date (uses other than wildlife-dependent public uses)

**NEPA Compliance for Refuge Use Decision:** (check one below)

____ Categorical Exclusion and Environmental Action Statement

____ Environmental Assessment and Finding of No Significant Impact

____ Environmental Impact Statement and Record of Decision

**Signatures:**

The Compatibility Determination for Research, Scientific Collecting, and Surveys is compatible with stipulations.

Prepared by:

Refuge Planner,
Hawaiian and Pacific Islands NWRC

_____ _____
(Signature) (Date)

Project Leader,
O,,ahu National Wildlife Refuge Complex
Approval:

_____ _____
(Signature) (Date)

**Concurrence:**

Project Leader,
Hawaiian and Pacific Islands NWRC

_____ _____
(Signature) (Date)

Regional Chief,
National Wildlife Refuge System:

_____ _____
(Signature) (Date)

**FINDING OF APPROPRIATENESS OF A REFUGE USE**

Refuge Name: James Campbell National Wildlife Refuge

Use: Research, Scientific Collecting, and Surveys

This form is not required for wildlife-dependent recreational uses; take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

| Decision Criteria: | YES | NO |
|---|---|---|
| (a) Do we have jurisdiction over the use? | ✔ | |
| (b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)? | ✔ | |
| (c) Is the use consistent with applicable Executive orders and Department and Service policies? | ✔ | |
| (d) Is the use consistent with public safety? | ✔ | |
| (e) Is the use consistent with goals and objectives in an approved management plan or other document? | ✔ | |
| (f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed? | ✔ | |
| (g) Is the use manageable within available budget and staff? | ✔ | |
| (h) Will this be manageable in the future within existing resources? | ✔ | |
| (i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources? | ✔ | |
| (j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future? | ✔ | |

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes _✓__ No __

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence. Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

**Not Appropriate_____ Appropriate_✓**

Refuge Manager:_____ Date:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use. If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence. If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

**FWS Form 3-2319**

**A compatibility determination is required before the use may be allowed.** **02/06**

## Attachment 1: Appropriate Uses Justification

**Date:** **September 16, 2010**

**Refuge:** James Campbell National Wildlife Refuge (Refuge)

**Project:** Research, Scientific Collecting, and Surveys

**Summary:** The Refuge receives requests to conduct scientific research on Refuge lands and waters. Research applicants must submit a proposal that would outline: (1) objectives of the study; (2) justification for the study; (3) detailed methodology and schedule; (4) potential impacts on Refuge wildlife and/or habitat, including disturbance (short-term and long-term), injury, or mortality; (5) personnel required; (6) costs to Refuge, if any; and (7) end products (i.e., reports, publications). Research proposals would be reviewed by Refuge staff, Regional Office Branch of Refuge Biology, and others as appropriate prior to the Refuge issuing a SUP. Projects will not be open-ended, and at a minimum, will be reviewed annually.

**For each of the findings listed on FWS Form 3-2319, a justification has been provided below:**

**a. Do we have jurisdiction over the use?**

Some or all of the proposed activities would take place within Refuge boundaries. The Refuge has jurisdiction over those research projects that are sited within Refuge boundaries.

**b. Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?**

Proposed research activities should comply with all applicable laws and regulations. Any restrictions or qualifications that are required to comply with law and regulations would be specified in the SUP. The State of Hawai„i DLNR was invited on two occasions to participate on core planning teams, but declined due to insufficient staffing. However, as this Appropriate Use Justification does not propose a significant deviation from the status quo, and no comments on this topic were received from the State during the comment period, we believe additional coordination was not necessary.

**c. Is the use consistent with applicable Executive orders and Department and Service policies?**

Through the review of individual projects, the Refuge would ensure that they are consistent with applicable policies, especially Research on Service Lands Policy (803 FW 1).

**d. Is the use consistent with public safety?**

Through individual project review, the Refuge will ensure that each project is consistent with public safety. If necessary, stipulations to ensure public safety will be included in the project‟s SUP.

**e. Is the use consistent with goals and objectives in an approved management plan or other document?**

Research activities are approved in instances where they can provide meaningful data that may contribute to Refuge management and public appreciation of natural resources.

**f. Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?**

Earlier documented analysis has approved the use and toted the benefits of research, scientific collecting, and surveys on national wildlife refuges.

**g. Is the use manageable within available budget and staff?**

The Refuge receives <10 requests per year for this activity, and it is manageable with available budget and staff.

**h. Will this be manageable in the future within existing resources?**

The proposed activity at current levels would be manageable in the future with the existing resources.

**i. Does the use contribute to the public's understanding and appreciation of the Refuge's natural or cultural resources, or is the use beneficial to the Refuge's natural or cultural resources?**

The proposed use is beneficial to the Refuge‟s natural and cultural resources because the types of research projects approved are those that have the distinct likelihood to help achieve Refuge purposes by providing information useful for the management of trust resources and may contribute to the public‟s understanding and appreciation of natural and/or cultural resources.

**j. Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?**

The Refuge will ensure that the research activities will not impair existing or future wildlife-dependent recreational use of the Refuge during individual project review, prior to issuing a SUP for the project.

**FINDING OF APPROPRIATENESS OF A REFUGE USE**

Refuge Name: James Campbell National Wildlife Refuge

Use: Commercial operation, sea asparagus farm

**This form is not required for wildlife-dependent recreational uses; take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.**

| Decision Criteria: | YES | NO |
|---|---|---|
| (a) Do we have jurisdiction over the use? | ✓ | |
| (b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)? | | ✓ |
| (c) Is the use consistent with applicable Executive orders and Department and Service policies? | | ✓ |
| (d) Is the use consistent with public safety? | ✓ | |
| (e) Is the use consistent with goals and objectives in an approved management plan or other document? | | ✓ |
| (f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed? | ✓ | |
| (g) Is the use manageable within available budget and staff? | | ✓ |
| (h) Will this be manageable in the future within existing resources? | | ✓ |
| (i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources? | ✓ | |
| (j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future? | | ✓ |

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the Refuge manager has consulted with State fish and wildlife agencies. Yes ✔ No __

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence. Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

**Not Appropriate ✔** **Appropriate____**

Refuge Manager:_____ Date:_____

If found to be **Not Appropriate**, the Refuge supervisor does not need to sign concurrence if the use is a new use. If an existing use is found **Not Appropriate** outside the CCP process, the Refuge supervisor must sign concurrence. If found to be **Appropriate**, the Refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

**FWS Form 3-2319**

**A compatibility determination is required before the use may be allowed.** **02/06**

## Attachment 1: Appropriate Uses Justification

**Date:** **June 1, 2011**

**Refuge:** James Campbell National Wildlife Refuge (Refuge)

**Proposed Use:** Commercial operation, sea asparagus farm

**Summary:** This small commercial business occupies land under the long-term Refuge lease of Ming Dynasty. This operation was not covered by the December 2008 purchase agreement with the James Campbell Company and is not covered as part of the Ming Dynasty lease and therefore does not have pre-existing rights. This commercial operation does not meet requirements of 50 CFR 27.92 or 50 CFR 27.97, regarding the use of Private Structures and Private Operations (commercial enterprise), respectively. The owner has been advised of this circumstance and has agreed to move to a new location. Due to the desire of the Service not to cause this small business undue hardship, we have provided up to 3 years from the date of purchase of the land for this owner to find and relocate to a suitable alternate location off-Refuge. This land was purchased in December of 2009 and must be vacated by December 2012.

**For each of the findings listed on FWS Form 3-2319, a justification has been provided below:**

**a. Do we have jurisdiction over the use?**

Yes. The proposed use takes place within Refuge boundaries.

**b. Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?**

No. This commercial operation does not meet requirements of 50 CFR 27.92 or 50 CFR 27.97, regarding the use of Private Structures and Private Operations (commercial enterprise), respectively.

**c. Is the use consistent with applicable Executive orders and Department and Service policies?**

No. This operation was not covered by the December 2008 purchase agreement with the James Campbell Company and is not covered as part of the Ming Dynasty lease and therefore does not have pre-existing rights.

**d. Is the use consistent with public safety?**

Yes. There are no public safety issues with this use.

**e. Is the use consistent with goals and objectives in an approved management plan or other document?**

No. The first goal is to protect and manage seasonal wetland habitats to meet the life-history needs of endangered waterbirds to promote their recovery.

**f. Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?**

Yes. This is the first time the use has been proposed as the land has just recently been acquired by the Refuge.

**g. Is the use manageable within available budget and staff?**

No. The Refuge has no staff available to manage coordination with this commercial operation.

**h. Will this be manageable in the future within existing resources?**

No. The proposed activity would not be manageable in the future with the existing resources.

**i. Does the use contribute to the public's understanding and appreciation of the Refuge's natural or cultural resources, or is the use beneficial to the Refuge's natural or cultural resources?**

The proposed use does not contribute to the public‟s understanding and appreciation of the Refuge‟s natural or cultural resources.

**j. Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?**

No. Commercial sea asparagus farming operations would impair existing or future wildlife-dependent recreational use of the Refuge.

**FINDING OF APPROPRIATENESS OF A REFUGE USE**

Refuge Name: James Campbell National Wildlife Refuge

Use: Private Aircraft Operation of abandoned runway (former Kahuku Army Airfield)

**This form is not required for wildlife-dependent recreational uses; take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.**

| Decision Criteria: | YES | NO |
|---|---|---|
| (a) Do we have jurisdiction over the use? | ✓ | |
| (b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)? | | ✓ |
| (c) Is the use consistent with applicable Executive orders and Department and Service policies? | | ✓ |
| (d) Is the use consistent with public safety? | | ✓ |
| (e) Is the use consistent with goals and objectives in an approved management plan or other document? | | ✓ |
| (f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed? | ✓ | |
| (g) Is the use manageable within available budget and staff? | | ✓ |
| (h) Will this be manageable in the future within existing resources? | | ✓ |
| (i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources? | | ✓ |
| (j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future? | | ✓ |

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the Refuge manager has consulted with State fish and wildlife agencies. Yes ✔ No __

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence. Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

**Not Appropriate ✔** **Appropriate____**

Refuge Manager:_____ Date:_____

If found to be **Not Appropriate**, the Refuge supervisor does not need to sign concurrence if the use is a new use. If an existing use is found **Not Appropriate** outside the CCP process, the Refuge supervisor must sign concurrence. If found to be **Appropriate**, the Refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

**FWS Form 3-2319**

**A compatibility determination is required before the use may be allowed.** **02/06**

# Attachment 1: Appropriate Uses Justification

**Date:** **June 1, 2011**

**Refuge:** James Campbell National Wildlife Refuge (Refuge)

**Proposed Use:** Use of abandoned runway (former Kahuku Army Airfield) for operation of aircraft (practice landings and takeoffs or other operation)

**Summary:** Remnant open portions of the former Kahuku Army Airfield runway still exist on lands recently purchased by the Service and now administered as part of the James Campbell NWR. Refuge management plans include removing existing encroaching invasive vegetation on the runway and aprons of the runway to improve the site as potential seabird nesting habitat. The current remnant runway is frequently used by migratory birds, including kioea and kōlea.

Under Federal regulations at 50 CFR 27.34, aircraft are prohibited from operating over national wildlife refuges at altitudes that result in harassment of wildlife and specifically prohibits unauthorized landings or take-offs. Due to the designated wildlife purposes of the James Campbell NWR and planned habitat management on and around the runway to benefit birds any request for authorized use of the runway would not be an appropriate use. As provided for in 50 CFR 27.34, emergency aircraft operations (i.e., emergency landings) are permitted.

**For each of the findings listed on FWS Form 3-2319, a justification has been provided below:**

**a. Do we have jurisdiction over the use?**

All of the proposed activities would take place within Refuge boundaries. The Refuge has jurisdiction over remnant open portions of the former Kahuku Army Airfield runway that are sited within Refuge boundaries.

**b. Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?**

No. Under Federal regulations at 50 CFR 27.34, aircraft are prohibited from operating over national wildlife refuges at altitudes that result in harassment of wildlife and specifically prohibits unauthorized landings or take-offs.

**c. Is the use consistent with applicable Executive orders and Department and Service policies?**

No. Due to the designated wildlife purpose of the James Campbell NWR and planned habitat management on and around the runway to benefit birds, any request for authorized use of the runway would not be an appropriate use.

**d. Is the use consistent with public safety?**

No. All aircraft are associated with different hazards. Members of the public would likely have no knowledge of important safety issues specific to an aircraft using an unsecured and unmanned landing area. Prior to Service acquisition, private helicopters landed in the vicinity of the old runway. The rotor wash, or air being blown by a hovering aircraft, is roughly 80-90 mph (more than a Category I hurricane) and it also reaches over 50 feet away. The other hazard of particular note is rotor strikes. Even highly experienced aircrews sometimes blindly walk into a spinning rotor and lose their lives. A sudden wind gust or pilot-input can suddenly and quickly change the pitch or angle of the rotor blade and bring it within head-strike distance. Many helicopters have tail rotors that are close to the ground and well within the head-strike zone. They also spin so fast as to be nearly invisible.

**e. Is the use consistent with goals and objectives in an approved management plan or other document?**

No. The Service proposes to improve potential seabird nesting sites on and around the abandoned Kahuku Airfield runway.

**f. Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?**

Yes. This is the first time the use has been proposed as the land has just recently been acquired by the Refuge.

**g. Is the use manageable within available budget and staff?**

No. The Refuge has no staff available to manage coordination with private aircraft.

**h. Will this be manageable in the future within existing resources?**

No. The proposed activity would not be manageable in the future with the existing resources.

**i. Does the use contribute to the public's understanding and appreciation of the Refuge's natural or cultural resources, or is the use beneficial to the Refuge's natural or cultural resources?**

The proposed use is detrimental to seabird nesting and does not contribute to the public‟s understanding and appreciation of the Refuge‟s natural or cultural resources.

**j. Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?**

No. Private aircraft operations would impair existing or future wildlife-dependent recreational use of the Refuge.

# Appendix C. Plan Implementation and Costs

## C.1 Administration

James Campbell National Wildlife Refuge is administered as part of the Oʻahu National Wildlife Refuge Complex. The Complex also includes the Pearl Harbor NWR, comprised of three separate units scattered along the south of Oʻahu and also the Oʻahu Forest NWR located in the higher elevations of the Koʻolau Mountains in central Oʻahu. The Complex headquarters is located in leased office space in the north shore town of Haleʻiwa, approximately 20 miles from the James Campbell NWR. The maintenance shop and equipment storage buildings that serve refuges in the entire Complex are located on the Kiʻi Unit. This site is located about 40 miles from the Pearl Harbor NWR units. A new Oʻahu NWR Complex headquarters/visitor center/environmental education facility is being proposed for construction on the Punamanō Unit. This facility and associated staff would also serve the Pearl Harbor NWR and Oʻahu Forest NWR.

## C.2 Staffing

Out of necessity, all staff positions share responsibilities and duties across all three refuges; i.e., no staff is assigned and performs duties only on specific refuges within the Complex. Due to projected Complex-wide workload, priorities, logistics, and supervisory considerations; this arrangement is expected to continue. However, when more personnel are added to the Complex, staff may be assigned more specific duties on individual refuges.

Necessary staffing for current Complex needs (as projected by the Service's National Staffing Model) was determined to include 20.5 staff positions. Of these, 2.5 staff positions were moved to other offices. Therefore, with the existing core (existing) funded complex staff of 6 personnel, 12 additional staff positions are justified under the National Staffing Model to meet current (existing) Refuge needs for the Complex, including James Campbell NWR. Increased staffing would allow more coordination with other Federal, State, and local agencies and the public; additional capacity to conduct biological inventory, monitoring, research, and habitat management; improved maintenance capability for all Refuge facilities; law enforcement; and visitor services (including interpretation and environmental education).

### C.2.1 Visitor Center and Environmental Education Center Staffing

A critical consideration in future staffing needs is in conjunction with construction of a proposed Headquarters/Visitor Center/Environmental Education Center facility (HQ/VC/EE). This would be a large state-of-the art facility designed and planned to serve up to 210,000 visitors and up to 10,000 students annually. This facility would be located on the James Campbell NWR but would serve all of the refuges of the Complex. To fully meet the operational needs and potential of this facility, three additional visitor services staff and one fulltime facility maintenance manager would be needed to maintain and operate the facility and grounds. These positions are included in the list below.

**Current and Necessary Permanent Full-time Staffing for O'ahu NWR Complex, including James Campbell NWR (**highlighted positions indicate current staff, * indicates VC/EE staff)

| Staff Position | Salary Rating | Staff Position | Salary Rating |
|---|---|---|---|
| Project Leader | GS-13 | Environmental Education Specialist | GS-7/9* |
| Deputy Project Leader | GS-11/12 | Park Ranger | GS-5/7/9* |
| Supervisory Wildlife Biologist | GS-11/12 | Tractor Operator | WG-6 |
| Supervisory Tractor Operator | WS-4 | Tractor Operator | WG-6 |
| Administrative Technician | GS-7/9 | Maintenance Worker | WG-8 |
| Supervisory Park Ranger | GS-11/12* | Maintenance Worker | WG-5/6/7 |
| Wildlife Refuge Manager | GS-7/9/11 | Maintenance Worker | WG-5/6 |
| Wildlife Biologist | GS-5/7/9 | Biological Technician | GS-5/7 |
| Refuge Law Enforcement Officer | GS-5/7/9 | Biological Technician | GS-5/7 |
| | | Facility Manager | WG-9/10* |

## C.4 Refuge Funding and Budget Requests

Successful and full implementation of the CCP relies on our ability to secure funding and staffing necessary to achieve the actions and strategies described in the CCP. In addition to annual budget allocations, funding can be received through special funding sources and programs geared toward specific resource issues/needs. Examples include grants or project specific funding for endangered species, wetlands, pest species control, coastal habitats, seabirds, climate change or sea level rise. Currently, budget requests through the Refuge Operating Needs System (RONS) for James Campbell NWR include four additional staff positions as part of the necessary positions identified above. The RONS system will be updated with new/additional projects that are approved under this CCP.

**Major project implementation schedule and costs****

| Project | Dates | Cost Estimate |
|---|---|---|
| Construct HQ/VC/EE facility | Dependent on Funding | $16,000,000 |
| Erect fences (by units) for dunes / coastal strand protection of seabirds and native vegetation | 2012 - 2016 | $580,000 |
| Restore/manage vegetation on abandoned runway as seabird nesting habitat | 2012 | $40,000 |
| Restoration of coastal dune/coastal strand habitat for nesting seabirds and native vegetation | 2012 - 2016 | $110,000 |
| Demolition/clean-up of abandoned aquaculture facilities | 2012 - 2014 | $450,000 |
| Install small water control structures to enhance management of degraded wetlands | 2013 - 2016 | $60,000 |
| Construct new shop/maintenance facility | 2014 - 2016 | $1,100,000 |
| Construct bunkhouse for volunteers/researchers | 2014 - 2018 | $850,000 |

**does not include projects, facilities (i.e., public roads, parking areas, boardwalks, trails, etc.) to be identified in Visitor Services Plan

## C.5 Stepdown Plans

The CCP is one of several plans necessary for refuge management. The CCP provides guidance in the form of goals, objectives, and strategies for several Refuge program areas but may lack some of the specifics needed for implementation. Stepdown management plans will be developed for individual program areas within approximately 5 years after CCP completion. Stepdown plans, where feasible, will be prepared to cover all refuges of the Complex with similar planning needs. Others will be prepared for specific refuges in the Complex. All stepdown plans require appropriate NEPA compliance; implementation may require additional permits. Stepdown plans for the Refuge follow in the table below. Project-specific plans, with appropriate NEPA compliance, may be prepared outside of these stepdown plans.

**Stepdown Management Plan Status**

| **Completed** | **Date** |
|---|---|
| Habitat Management Plan | 2011 (CCP meets requirements for HMP) |
| Integrated Pest Management Plan | 2011 (prepared concurrently with CCP, Appendix E) |
| Occupational Safety and Health Plan | 2007 |
| Fire Management Plan | 2007 |
| | |
| **Scheduled** | |
| Fishing Plan | Initiate by 2012 |
| Land Protection Plan | Initiate by 2012 |
| Climate Change Monitoring Plan | Initiate by 2012 |
| Inventory and Monitoring Plan | 2014 |
| Visitor Services Plan | Complete by 2016 |
| Transportation Plan | 2016 |
| Environmental Education Plan | 2016 |
| | |
| **Studies Identified in CCP strategies** | |
| Hydrogeomorphic Study | Initiate by 2014 |
| Comprehensive Water Resources Study | 2018-2020 |

# Appendix D: Wilderness Review for James Campbell National Wildlife Refuge

## General Information on Wilderness Reviews

Wilderness review is the process used to determine whether or not to recommend lands or waters in the Refuge System to the Congress for designation as wilderness. Planning policy for the System (602 FW 3) mandates conducting wilderness reviews every 15 years through the CCP process.

The wilderness review process has three phases: inventory, study, and recommendation. After first identifying lands and waters that meet the minimum criteria for wilderness, the resulting wilderness study areas (WSA) are further evaluated to determine if they merit recommendation from the Service to the Secretary of the Interior for inclusion in the National Wilderness Preservation System (NWPS). Areas recommended for designation are managed to maintain wilderness character in accordance with management goals, objectives, and strategies outlined in the final CCP until Congress makes a decision or the CCP is amended to modify or remove the wilderness proposal. A brief discussion of wilderness inventory, study, and recommendation follows.

### Wilderness Inventory

The wilderness inventory consists of identifying areas that minimally meet the requirements for wilderness as defined in the Wilderness Act of 1964 (Wilderness Act). Wilderness is defined as an area which:

- Has at least 5,000 ac of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition, or be capable of restoration to wilderness character through appropriate management at the time of review, or be a roadless island;
- Generally appears to have been affected primarily by the forces of nature, with the imprint of man‟s work substantially unnoticeable;
- Has outstanding opportunities for solitude or a primitive and unconfined type of recreation; and
- May also contain ecological, geological, or other features of scientific, educational, scenic, or historic value. These features and values, though desirable, are not necessary for an area to qualify as a wilderness.

### Wilderness Study

During the study phase, lands and waters qualifying for wilderness as a result of the inventory are studied to analyze values (ecological, recreational, cultural, spiritual), resources (wildlife, water, vegetation, minerals, soils), and uses (habitat management, public use) within the area. The findings of the study help determine whether to recommend the area for designation as wilderness.

### Wilderness Recommendation

Once a wilderness study determines that a WSA meets the requirements for inclusion in the NWPS, a wilderness study report that presents the results of the wilderness review, accompanied by a Legislative Environmental Impact Statement (LEIS), is prepared. The wilderness study report and LEIS that support wilderness designation are then transmitted through the Secretary of the Interior to the President of the United States, and ultimately to the Congress for approval.

The following section summarizes the inventory phase of the wilderness review for James Campbell NWR.

## Wilderness Inventory

The wilderness inventory is a broad look at the planning area to identify WSAs. These WSAs are roadless areas within refuge boundaries, including submerged lands and their associated water column, that meet the minimum criteria for wilderness identified in Sect. 2. (c) of the Wilderness Act. A WSA must meet the minimum size criteria (or be a roadless island), appear natural, and provide outstanding opportunities for solitude or primitive recreation. Other supplemental values are evaluated, but not required.

Evaluation of Size Criteria for Roadless Areas, Roadless Islands, and Submergent Lands and Associated Water Column

Identification of roadless areas, roadless islands, and submerged lands and associated water column, required gathering land status maps, land use and road inventory data, satellite imagery, aerial photographs, and personal observations of areas within refuge boundaries. "Roadless" refers to the absence of improved roads suitable and maintained for public travel by means of motorized vehicles primarily intended for highway use.

Inventory units meet the size criteria for a WSA if any one of the following standards applies:

- An area with over 5,000 contiguous ac. State and private lands are not included in making this acreage determination.
- A roadless island of any size. A roadless island is defined as an area surrounded by permanent waters or that is markedly distinguished from the surrounding lands by topographical or ecological features.
- An area of less than 5,000 contiguous Federal acres that is of sufficient size as to make practicable its preservation and use in an unimpaired condition, and of a size suitable for wilderness management.
- An area of less than 5,000 contiguous Federal acres that is contiguous with a designated wilderness, recommended wilderness, or area under wilderness review by another Federal wilderness managing agency such as the Forest Service, National Park Service, or Bureau of Land Management.

The Refuge is composed of a highly modified land management unit totaling 934 acres on the island of O,ahu and does not meet the size criteria. It is also bounded and bisected by State-owned and Refuge-owned roadways maintained for travel by passenger vehicles.

Evaluation of the Naturalness Criteria

A WSA must meet the naturalness criteria. Section 2.(c) of the Wilderness Act defines wilderness as an area that "…generally appears to have been affected primarily by the forces of nature with the imprint of man's work substantially unnoticeable." The area must appear natural to the average visitor rather than "pristine." The presence of ecologically accurate, historical landscape conditions is not required. An area may include some manmade features and human impacts provided they are substantially unnoticeable in the unit as a whole. Human-caused hazards, such as the presence of unexploded ordnance from military activity, and the physical impacts of refuge management facilities and activities are also considered in the evaluation of the naturalness criteria. An area may not be considered unnatural in appearance solely on the basis of "sights and sounds" of human

impacts and activities outside the boundary of the unit. The cumulative effects of these factors were considered in the evaluation of naturalness for each wilderness inventory unit.

In the wilderness inventory, specific manmade features and other human impacts need to be identified that affect the overall apparent naturalness of the tract. The following factors were primary considerations in evaluating the naturalness of the Refuge:

- Administrative and maintenance buildings, abandoned aquaculture facilities;
- Well pumps, earthen dikes, water control structures; and
- Gates, parking lots, and roadways.

The Refuge consists of highly modified lands, containing earthen dikes, ditches, water control structures, buildings, and water pumping stations and does not meet the naturalness criteria.

Evaluation of Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation

In addition to meeting the size and naturalness criteria, a WSA must provide outstanding opportunities for solitude or primitive recreation. The area does not have to possess outstanding opportunities for both solitude and primitive and unconfined recreation, and does not need to have outstanding opportunities on every acre. Further, an area does not have to be open to public use and access to qualify under these criteria. Congress has designated a number of wilderness areas in the NWPS that are closed to public access to protect ecological resource values.

Opportunities for solitude refers to the ability of a visitor to be alone and secluded from other visitors in the area. Primitive and unconfined recreation means nonmotorized, dispersed outdoor recreation activities that do not require developed facilities or mechanical transport. These primitive recreation activities may provide opportunities to experience challenge and risk, self reliance, and adventure.

These two opportunity “elements” are not well defined by the Wilderness Act but in most cases can be expected to occur together. However, an outstanding opportunity for solitude may be present in an area offering only limited primitive recreation potential. Conversely, an area may be so attractive for recreation use that experiencing solitude is not an option.

This Refuge does not offer opportunities for solitude or primitive and unconfined recreation. Daily management activities occur throughout the Refuge. These activities include road maintenance, mowing and disking of fields, and manipulation of water control structures. Recreational and educational activities are only conducted in group settings, and only allowed as staff-guided activities.

Evaluation of Supplemental Values

Supplemental values are defined by the Wilderness Act as “ecological, geological, or other features of scientific, educational, scenic, or historic value.” Based upon the findings of the required components for WSA designation, supplemental values were not evaluated.

Findings

James Campbell NWR does not meet the minimum criteria for consideration as a WSA (see Table D.1).

## Table D.1 Wilderness Inventory Summary

| Wilderness Inventory Summary<br>James Campbell NWR (1,100 acres) | |
|---|---|
| **Required Components** | |
| (1) Has at least 5,000 ac of land or is of sufficient size to make practicable its preservation and use in an unconfined condition, or is a roadless island. | No. Does not contain 5,000 acres, is not a roadless island, and is not practicable to manage as a wilderness. |
| (2) Generally appears to have been affected primarily by the forces of nature, with the imprint of man‟s work substantially unnoticeable. | No. Landscape is highly modified and actively managed. |
| (3a) Has outstanding opportunities for solitude. | No. Refuge is actively and regularly managed. |
| (3b) Has outstanding opportunities for a primitive and unconfined type of recreation. | No. Recreation is highly regulated and requires staff presence. |
| **Other Components** | |
| (4) Contains ecological, geological or other features of scientific, educational, scenic, or historic value. | Not evaluated. |
| **Summary** | |
| Parcel qualifies as a wilderness study area (meets criteria 1, 2 & 3a or 3b). | No. |

# Appendix E: Integrated Pest Management (IPM) Program

## 1.0 Background

IPM is an interdisciplinary approach utilizing methods to prevent, eliminate, contain, and/or control pest species in concert with other management activities on Refuge lands and waters to achieve wildlife and habitat management goals and objectives. IPM is also a scientifically based, adaptive management process where available scientific information and best professional judgment of the Refuge staff as well as other resource experts would be used to identify and implement appropriate management strategies that can be modified and/or changed over time to ensure effective, site-specific management of pest species to achieve desired outcomes. In accordance with 43 CFR 46.145, adaptive management would be particularly relevant where long-term impacts may be uncertain and future monitoring would be needed to make adjustments in subsequent implementation decisions. After a tolerable pest population (threshold) is determined considering achievement of Refuge resource objectives and the ecology of pest species, one or more methods, or combinations thereof, are selected that are feasible, efficacious, and most protective of nontarget resources, including native species (fish, wildlife, and plants), and Service personnel, Service authorized agents, volunteers, and the public. Staff time and available funding will be considered when determining feasibility/practicality of various treatments.

IPM techniques to address pests are presented as CCP strategies prescriptions (see Section 2.0 of this CCP) in an adaptive management context to achieve Refuge resource objectives. In order to satisfy requirements for IPM planning as identified in the Director"s Memo (dated September 9, 2004) entitled *Integrated Pest Management Plans and Pesticide Use Proposals: Updates, Guidance, and an Online Database*, the following elements of an IPM program have been incorporated into this CCP:

- Habitat and/or wildlife objectives that identify pest species and appropriate thresholds to indicate the need for and successful implementation of IPM techniques; and
- Monitoring before and/or after treatment to assess progress toward achieving objectives including pest thresholds.

Where pesticides would be necessary to address pests, this Appendix provides a structured procedure to evaluate potential effects of proposed uses involving ground-based applications to Refuge biological resources and environmental quality in accordance with effects analyses presented in Chapter 6 of this CCP. Only pesticide uses that likely would cause minor, temporary, or localized effects to Refuge biological resources and environmental quality with appropriate best management practices (BMPs), where necessary, would be allowed for use on the Refuge.

This Appendix does not describe the more detailed process to evaluate potential effects associated with aerial applications of pesticides. Moreover, it does not address effects of mosquito control with pesticides (larvicides, pupacides, or adulticides) based upon identified human health threats and presence of disease-carrying mosquitoes in sufficient numbers from monitoring conducted on a Refuge. However, the basic framework to assess potential effects to Refuge biological resources and environmental quality from aerial application of pesticides or use of insecticides for mosquito management would be similar to the process described in this Appendix for ground-based treatments of other pesticides.

## 2.0 Pest Management Laws and Policies

In accordance with 517 DM and 569 FW 1(Integrated Pest Management), plant, invertebrate, and vertebrate pests on units of the National Wildlife Refuge System can be controlled to assure balanced wildlife and fish populations in support of refuge-specific wildlife and habitat management objectives. Pest control on Federal (Refuge) lands and waters also is authorized under the following legal mandates:

- National Wildlife Refuge System Administration Act of 1966, as amended (16 USC 668dd-668ee);
- Plant Protection Act of 2000 (7 USC 7701 *et seq*.);
- Noxious Weed Control and Eradication Act of 2004 (7 USC 7781-7786, Subtitle E);
- Federal Insecticide, Fungicide, and Rodenticide Act of 1996 (7 USC 136-136y);
- National Invasive Species Act of 1996 (16 USC 4701);
- Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (16 USC 4701);
- Food Quality Protection Act of 1996 (7 USC 136);
- Executive Order 13148, Section 601(a);
- Executive Order 13112; and
- Animal Damage Control Act of 1931 (7 USC 426-426c, 46 Stat. 1468).

Pests are defined as "…living organisms that may interfere with the site-specific purposes, operations, or management objectives or that jeopardize human health or safety" from Department policy 517 DM 1 (Integrated Pest Management Policy). Similarly, 569 FW 1 defines pests as "…invasive plants and introduced or native organisms, that may interfere with achieving our management goals and objectives on or off our lands, or that jeopardize human health or safety." 517 DM 1 also defines an invasive species as "a species that is nonnative to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Throughout the remainder of this CCP, the terms pest and invasive species are used interchangeably because both can prevent/impede achievement of Refuge wildlife and habitat objectives and/or degrade environmental quality.

In general, control of pests (vertebrate or invertebrate) on the Refuge would conserve and protect the nation"s fish, wildlife, and plant resources as well as maintain environmental quality. From 569 FW 1, animal or plant species, which are considered pests, may be managed if the following criteria are met:

- Threat to human health and well being or private property, the acceptable level of damage by the pest has been exceeded, or State or local government has designated the pest as noxious;
- Detrimental to resource objectives as specified in a Refuge resource management plan (e.g., comprehensive conservation plan, habitat management plan), if available; and
- Control would not conflict with attainment of resource objectives or the purposes for which the Refuge was established.

The specific justifications for pest management activities on the Refuge are the following:

- Protect human health and well being;
- Prevent substantial damage to important to Refuge resources;
- Protect newly introduced or re-establish native species;
- Control nonnative (exotic) species in order to support existence for populations of native species;

- Prevent damage to private property; and
- Provide the public with quality, compatible wildlife-dependent recreational opportunities.

In accordance with Service policy 620 FW 1 (Habitat Management Plans), there are additional management directives regarding invasive species found on the Refuge:

- "We are prohibited by Executive Order, law, and policy from authorizing, funding, or carrying out actions that are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere."
- "Manage invasive species to improve or stabilize biotic communities to minimize unacceptable change to ecosystem structure and function and prevent new and expanded infestations of invasive species. Conduct Refuge habitat management activities to prevent, control, or eradicate invasive species..."

Animal species damaging/destroying Federal property and/or detrimental to the management program of a Refuge may be controlled as described in 50 CFR 31.14 (Official Animal Control Operations)**.**

Trespass and feral animals also may be controlled on Refuge lands. Based upon 50 CFR 28.43 (Destruction of Dogs and Cats), dogs and cats running at large on a national wildlife refuge and observed in the act of killing, injuring, harassing or molesting humans or wildlife may be disposed of in the interest of public safety and protection of the wildlife.

Feral animals should be disposed by the most humane method(s) available and in accordance with relevant Service directives (including Executive Order 11643). Disposed wildlife specimens may be donated or loaned to public institutions. Donation or loans of resident wildlife species will only be made after securing State approval (50 CFR 30.11 [Donation and Loan of Wildlife Specimens]**).** Surplus wildlife specimens may be sold alive or butchered, dressed and processed subject to Federal and State laws and regulations (50 CFR 30.12 [Sale of Wildlife Specimens]**).**

## 3.0 Strategies

To fully embrace IPM as identified in 569 FW 1, the following strategies, where applicable, would be carefully considered on the Refuge for each pest species:

**Prevention.** This would be the most effective and least expensive long-term management option for pests. It encompasses methods to prevent new introductions or the spread of the established pests to un-infested areas. It requires identifying potential routes of invasion to reduce the likelihood of infestation. Hazard Analysis and Critical Control Points (HACCP) planning can be used determine if current management activities on a Refuge may introduce and/or spread invasive species in order to identify appropriate BMPs for prevention.

Prevention may include source reduction, using pathogen-free or weed-free seeds or fill; exclusion methods (e.g., barriers) and/or sanitation methods (e.g., wash stations) to prevent re-introductions by various mechanisms including vehicles and personnel. Because invasive species are frequently the first to establish newly disturbed sites, prevention would require a reporting mechanism for early detection of new pest occurrences with quick response to eliminate any new satellite pest populations. Prevention would require consideration of the scale and scope of land management activities that may promote pest establishment within un-infested areas or promote

reproduction and spread of existing populations. Along with preventing initial introduction, prevention would involve halting the spread of existing infestations to new sites (Mullin et al. 2000). The primary reason of prevention would be to keep pest-free lands or waters from becoming infested. Executive Order 11312 emphasizes the priority for prevention with respect to managing pests.

The following would be methods to prevent the introduction and/or spread of pests on Refuge lands:

- Before beginning ground-disturbing activities (e.g., disking, scraping), inventory and prioritize pest infestations in project operating areas and along access routes. Refuge staff would identify pest species on site or within reasonably expected potential invasion vicinity. Where possible, Refuge staff would begin project activities in un-infested areas before working in pest-infested areas.
- Refuge staff would locate and use pest-free project staging areas. They would avoid or minimize travel through pest-infested areas, or restrict to those periods when spread of seed or propagules of invasive plants would be least likely.
- Refuge staff would determine the need for, and when appropriate, identify sanitation sites where equipment can be cleaned of pests. Where possible, Refuge staff would clean equipment before entering lands at on-Refuge approved cleaning site(s). This practice does not pertain to vehicles traveling frequently in and out of the project area that will remain on roadways. Seeds and plant parts of pest plants would need to be collected, where practical. Refuge staff would remove mud, dirt, and plant parts from project equipment before moving it into a project area.
- Refuge staff would clean all equipment, before leaving the project site, if operating in areas infested with pests. Refuge staff would determine the need for, and when appropriate, identify sanitation sites where equipment can be cleaned.
- Refuge staffs, their authorized agents, and Refuge volunteers would, where possible, inspect, remove, and properly dispose of seed and parts of invasive plants found on their clothing and equipment. Proper disposal means bagging the seeds and plant parts and then properly discarding of them (e.g., incinerating).
- Refuge staff would evaluate options, including closure, to restrict the traffic on sites with on-going restoration of desired vegetation. Refuge staff would revegetate disturbed soil (except travel ways on surfaced projects) to optimize plant establishment for each specific site. Revegetation may include topsoil replacement, planting, seeding, fertilization, liming, and weed-free mulching as necessary. Refuge staff would use native material, where appropriate and feasible. Refuge staff would use certified weed-free or weed-seed-free hay or straw where certified materials are reasonably available.
- Refuge staff would provide information, training and appropriate pest identification materials to Refuge staffs, permit holders, and recreational visitors. Refuge staff would educate them about pest identification, biology, impacts, and effective prevention measures.
- Refuge staff would inspect borrow material for invasive plants prior to use and transport onto and/or within Refuge lands.
- Refuge staff would consider invasive plants in planning for road maintenance activities.
- Refuge staff would restrict off road travel to designated routes.

The following would be methods to prevent the introduction and/or spread of pests into Refuge waters:

- Refuge staff would inspect boats (including air boats), trailers, and other boating equipment and, where possible, remove any visible plants, animals, or mud before leaving any waters or boat launching facilities. Where possible, staff would drain water from motor, live well, bilge, and transom wells while on land before leaving the site.

If possible, Refuge staff would wash and dry boats, downriggers, anchors, nets, floors of boats, propellers, axles, trailers, and other boating equipment to kill pests not visible at the boat launch. These prevention methods to minimize/eliminate the introduction and/or spread of pests were taken verbatim or slightly modified from Appendix E of US Forest Service (2005).

- **Mechanical/Physical Methods.** These methods would remove and destroy, disrupt the growth of, or interfere with the reproduction of pest species. For plants species, these treatments can be accomplished by hand, hand tool (manual), or power tools (mechanical) and include pulling, grubbing, digging, tilling/disking, cutting, swathing, grinding, sheering, girdling, mowing, and mulching of the pest plants.

  For animal species, Service employees or their authorized agents could use mechanical/physical methods (including trapping) to control pests as a refuge management activity. Based upon 50 CFR 31.2, trapping can be used on a refuge to reduce surplus wildlife populations for a "balanced conservation program" in accordance with Federal or State laws and regulations. In some cases, nonlethally trapped animals would be relocated to off-refuge sites with prior approval from the State.

  Each of these tools would be efficacious to some degree and applicable to specific situations. In general, mechanical controls can effectively control annual and biennial pest plants. However, to control perennial plants, the root system has to be destroyed or it would resprout and continue to grow and develop. Mechanical controls are typically not capable of destroying a perennial plants root system. Although some mechanical tools (e.g., disking, plowing) may damage root systems, they may stimulate regrowth producing a denser plant population that may aid in the spread depending upon the target species. In addition, steep terrain and soil conditions would be major factors that can limit the use of many mechanical control methods.

  Some mechanical control methods (e.g., mowing), which would be used in combination with herbicides, can be a very effective technique to control perennial species. For example, mowing perennial plants followed sequentially by treating the plant regrowth with a systemic herbicide often would improve the efficacy of the herbicide compared to herbicide treatment only.

- **Cultural Methods.** These methods would involve manipulating habitat to increase pest mortality by reducing its suitability to the pest. Cultural methods would include water-level manipulation, , prescribed burning (facilitate revegetation, increase herbicide efficacy, and remove litter to assist in emergence of desirable species), planting or seeding desirable species to shade or out-compete invasive plants, applying fertilizer to enhance desirable vegetation, irrigation, and other habitat alterations.

- **Biological Control Agents.** Classical biological control would involve the deliberate introduction and management of natural enemies (parasites, predators, or pathogens) to reduce pest populations. Many of the most ecologically or economically damaging pest species in the United States originated in foreign countries. These newly introduced pests, which are free from

natural enemies found in their country or region of origin, may have a competitive advantage over cultivated and native species. This competitive advantage often allows introduced species to flourish, and they may cause widespread economic damage to crops or out compete and displace native vegetation. Once the introduced pest species population reaches a certain level, traditional methods of pest management may be cost prohibitive or impractical. Biological controls typically are used when these pest populations have become so widespread that eradication or effective control would be difficult or no longer practical.

Biological control has advantages as well as disadvantages. Benefits would include reducing pesticide usage, host specificity for target pests, long-term self-perpetuating control, low cost/acre, capacity for searching and locating hosts, synchronizing biological control agents to hosts‟ life cycles, and the unlikelihood that hosts will develop resistance to agents. Disadvantages would include the following: limited availability of agents from their native lands, the dependence of control on target species density, slow rate at which control occurs, biotype matching, the difficulty and expense of conflicts over control of the target pest, and host specificity when host populations are low.

A reduction in target species populations from biological controls is typically a slow process, and efficacy can be highly variable. It may not work well in a particular area although it does work well in other areas. Biological control agents would require specific environmental conditions to survive over time. Some of these conditions are understood; whereas, others are only partially understood or not at all.

Biological control agents would not eradicate a target pest. When using biological control agents, residual levels of the target pest typically are expected; the agent population level or survival would be dependent upon the density of its host. After the pest population decreases, the population of the biological control agent would decrease correspondingly. This is a natural cycle. Some pest populations (e.g., invasive plants) would tend to persist for several years after a biological control agent becomes established due to seed reserves in the soil, inefficiencies in the agents search behavior, and the natural lag in population buildup of the agent.

The full range of pest groups potentially found on refuge lands and waters would include diseases, invertebrates (insects, mollusks), vertebrates and invasive plants (most common group). Often it is assumed that biological control would address many if not most of these pest problems. Introduced species without desirable close relatives in the United States would generally be selected as biological controls. Natural enemies that are restricted to one or a few closely related plants in their country of origin are targeted as biological controls (Center et al. 1997, Hasan and Ayres 1990).

The Hawai`i Department of Agriculture (HDOA) has a highly successful bio-control program for the erythrina gall wasp which has resulted in the rebounding of the native wiliwili trees. In June 2010, HDOA began another biological control program that releases a tiny parasitic insect to control the stinging Nettle Caterpillar. The release of Brazilian scale to slow the growth rate and spread of strawberry guava has recently been proposed to give Hawai„ï‟s native plants a chance for survival, protect the ability of the forests to provide water, and provide better protection for agricultural crops from the fruit flies that breed in the overabundance of strawberry guava fruit. Due to the success of Hawai`i‟s biocontrol programs, the State has become a leader in the world on the use of biological control to fight invasive pests.

Refuge staff would ensure introduced agents are approved by the applicable authorities. Except for a small number of formulated biological control products registered by USEPA under FIFRA, most biological control agents are regulated by the U.S. Department of Agriculture (USDA)-Animal Plant Health Inspection Service, Plant Protection and Quarantine (APHIS-PPQ). State departments of agriculture and, in some cases, county agricultural commissioners or weed districts, have additional approval authority.

Federal permits (USDA-APHIS-PPQ Form 526) are required to import biocontrol agents from another State. Form 526 may be obtained by writing:

USDA-APHIS-PPQ
Biological Assessment and Taxonomic Support
4700 River Road, Unit 113
Riverdale, MD 20737

or

through the internet at URL address:
http://www.aphis.usda.gov/ppq/permits/bioligical/weedbio.html.

The Service strongly supports the development, and legal and responsible use of appropriate, safe, and effective biological control agents for nuisance and nonindigenous or pest species.

State and county agriculture departments may also be sources for biological control agents or they may have information about where biological control agents may be obtained. Commercial sources should have an Application and Permit to Move Live Plant Pests and Noxious Weeds (USDA-PPQ Form 226 USDA-APHIS-PPQ, Biological Assessment and Taxonomic Support, 4700 River Road, Unit 113, Riverdale, MD 20737) to release specific biological control agents in a State and/or county. Furthermore, certification regarding the biological control agent‟s identity (genus, specific epithet, sub-species and variety) and purity (e.g., parasite free, pathogen free, and biotic and abiotic contaminants) should be specified in purchase orders.

Biological control agents are subject to 569 FW 1. In addition, Refuge staff would follow the International Code of Best Practice for Classical Biological Control of Weeds (http://sric.ucdavis.edu/exotic /exotic.htm) as ratified by delegates to the X International Symposium on Biological Control of Weeds, Bozeman, MT, July 9, 1999. This code identifies the following:

- Release only approved biological control agents,
- Use the most effective agents,
- Document releases, and
- Monitor for impact to the target pest, nontarget species and the environment.

Biological control agents formulated as pesticide products and registered by the USEPA (e.g., *Bti*) are also subject to PUP review and approval (see below).

A record of all releases would be maintained with date(s), location(s), and environmental conditions of the release site(s); the identity, quantity, and condition of the biological control agents released; and other relevant data and comments such as weather conditions. Systematic monitoring to determine the establishment and effectiveness of the release is also recommended.

NEPA documents regarding biological and other environmental effects of biological control agents prepared by another Federal agency, where the scope is relevant to evaluation of releases on Refuge lands, would be reviewed. Possible source agencies for such NEPA documents include the Bureau of Land Management, U.S. Forest Service, National Park Service, U.S. Department of Agriculture-Animal and Plant Health Inspection Service, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s) from the review. Incorporating by reference (43 CFR 46.135) is a technique used to avoid redundancies in analysis. It also can reduce the bulk of a Service NEPA document, which only must identify the documents that are incorporated by reference. In addition, relevant portions must be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of relevance of the referenced material to the current analysis.

- **Pesticides.** The selective use of pesticides would be based upon pest ecology (including mode of reproduction), the size and distribution of its populations, site-specific conditions (e.g., soils, topography), known efficacy under similar site conditions, and the capability to utilize best management practices (BMPs) to reduce/eliminate potential effects to nontarget species, sensitive habitats, and potential to contaminate surface and groundwater. All pesticide usage (pesticide, target species, application rate, and method of application) would comply with the applicable Federal (FIFRA) and State regulations pertaining to pesticide use, safety, storage, disposal, and reporting. Before pesticides can be used to eradicate, control, or contain pests on Refuge lands and waters, pesticide use proposals (PUPs) would be prepared and approved in accordance with 569 FW 1. PUP records would provide a detailed, time-, site-, and target-specific description of the proposed use of pesticides on Refuge. All PUPs would be created, approved or disapproved, and stored in the Pesticide Use Proposal System (PUPS), which is a centralized database only accessible on the Service"s intranet (https://systems.fws.gov/pups). Only Service employees would be authorized to access PUP records for a Refuge in this database.

  Application equipment would be selected to provide site-specific delivery to target pests while minimizing/eliminating direct or indirect (e.g., drift) exposure to nontarget areas and degradation of surface and groundwater quality. Where possible, target-specific equipment (e.g., backpack sprayer, wiper) would be used to treat target pests. Other target-specific equipment to apply pesticides would include soaked wicks or paint brushes for wiping vegetation and lances, hatchets, or syringes for direct injection into stems. Granular pesticides may be applied using seeders or other specialized dispensers. In contrast, aerial spraying (e.g., fixed wing or helicopter) would only be used where access is difficult (remoteness) and/or the size/distribution of infestations precludes practical use of ground-based methods.

  Because repeated use of one pesticide may allow resistant organisms to survive and reproduce, multiple pesticides with variable modes of action would be considered for treatments on Refuge lands and waters. This is especially important if multiple applications within years and/or over a growing season likely would be necessary for habitat maintenance and restoration activities to achieve resource objectives. Integrated chemical and nonchemical controls also are highly effective, where practical, because pesticide resistant organisms can be removed from the site.

  Cost may not be the primary factor in selecting a pesticide for use on the Refuge. If the least expensive pesticide would potentially harm natural resources or people, then a different product would be selected, if available. The most efficacious pesticide available with the least potential to degrade environment quality (soils, surface water, and groundwater) as well as least potential

effect to native species and communities of fish, wildlife, plants, and their habitats would be acceptable for use on Refuge lands in the context of an IPM approach.

- **Habitat restoration/maintenance.** Restoration and/or proper maintenance of Refuge habitats associated with achieving wildlife and habitat objectives would be essential for long-term prevention, eradication, or control (at or below threshold levels) of pests. Promoting desirable plant communities through the manipulation of species composition, plant density, and growth rate is an essential component of invasive plant management (Masters et al. 1996, Masters and Shelly 2001, Brooks et al. 2004). The following three components of succession could be manipulated through habitat maintenance and restoration: site availability, species availability, and species performance (Cox and Anderson 2004). Although a single method (e.g., herbicide treatment) may eliminate or suppress pest species in the short term, the resulting gaps and bare soil create niches that are conducive to further invasion by the species and/or other invasive plants. On degraded sites where desirable species are absent or in low abundance, revegetation with native/desirable grasses, forbs, and legumes may be necessary to direct and accelerate plant community recovery, and achieve site-specific objectives in a reasonable time frame. The selection of appropriate species for revegetation would be dependent on a number of factors including resource objectives and site-specific, abiotic factors (e.g., soil texture, precipitation/temperature regimes, and shade conditions). Seed availability and cost, ease of establishment, seed production, and competitive ability also would be important considerations.

## 4.0 Priorities for Treatments

The magnitude (number, distribution, and sizes of infestations) for pest problems is too extensive and beyond the available capital resources to effectively address during any single field season. To manage pests in Refuge, it would be essential to prioritize treatment of infestations. Highest priority treatments would be focused on early detection and rapid response to eliminate infestations of new pests, if possible. This would be especially important for aggressive pests potentially impacting species, species groups, communities, and/or habitats associated Refuge purpose(s), System resources of concern (federally listed species, migratory birds, selected marine mammals, and interjurisdictional fish), and native species for maintaining/restoring biological integrity, diversity, and environmental health.

The next priority would be treating established pests that appear in one or more previously uninfested areas. Moody and Mack (1988) demonstrated through modeling that small, new outbreaks of invasive plants eventually would infest an area larger than the established, source population. They also found that control efforts focusing on the large, main infestation rather than the new, small satellites reduced the chances of overall success. The lowest priority would be treating large infestations (sometimes monotypic stands) of well established pests. In this case, initial efforts would focus upon containment of the perimeter followed by work to control/eradicate the established infested area. If containment and/or control of a large infestation is not effective, then efforts would focus upon halting pest reproduction or managing source populations. Maxwell et al. (2009) found treating fewer populations that are sources represents an effective long-term strategy to reduce of total number of invasive populations and decreasing meta population growth rates.

Although State listed noxious weeds would always of high priority for management, other pest species known to cause substantial ecological impact would also be considered. For example, short-spined kiawe may not be listed by a State as noxious, but it can greatly alter fire regimes in the

coastal dryland shrub habitat resulting in large monotypic stands that displace native bunch grasses, forbs, and shrubs. Pest control would likely require a multi-year commitment from Refuge staff. Essential to the long-term success of pest management would be pre- and post-treatment monitoring, assessment of the successes and failures of treatments, and development of new approaches when proposed methods do not achieve desired outcomes.

## 5.0 Best Management Practices (BMPs)

BMPs can minimize or eliminate possible effects associated with pesticide usage to nontarget species and/or sensitive habitats as well as degradation of water quality from drift, surface runoff, or leaching. Based upon the Department of the Interior Pesticide Use Policy (517 DM 1) and the Service Pest Management Policy and Responsibilities (30 AM 12), the use of applicable BMPs (where feasible) also would likely ensure that pesticide uses may not adversely affect federally listed species and/or their critical habitats through determinations made using the process described in 50 CFR part 402.

The following are BMPs pertaining to mixing/handling and applying pesticides for all ground-based treatments of pesticides, which would be considered and utilized, where feasible, based upon target- and site-specific factors and time-specific environmental conditions. Although not listed below, the most important BMP to eliminate/reduce potential impacts to nontarget resources would be an IPM approach to prevent, control, eradicate, and contain pests.

### 5.1 Pesticide Handling and Mixing

- As a precaution against spilling, spray tanks would not be left unattended during filling.
- All pesticide containers would be triple rinsed and the rinsate would be used as water in the sprayer tank and applied to treatment areas.
- All pesticide spray equipment would be properly cleaned. Where possible, rinsate would be used as part of the make up water in the sprayer tank and applied to treatment areas.
- Refuge staff would empty, triple rinsed pesticide containers that can be recycled at local herbicide container collections.
- All unused pesticides would be properly discarded at a local “safe send” collection.
- Pesticides and pesticide containers would be lawfully stored, handled, and disposed of in accordance with the label and in a manner safeguarding human health, fish, and wildlife and prevent soil and water contaminant.
- Refuge staff would consider the water quality parameters (e.g., pH, hardness) that are important to ensure greatest efficacy where specified on the pesticide label.
- All pesticide spills would be addressed immediately using procedures identified in Refuge spill respond plan.

### 5.2 Applying Pesticides

- Pesticide treatments would only be conducted by or under the supervision of Service personnel and non-Service applicators with the appropriate, State or BLM certification to safely and effectively conduct these activities on Refuge lands and waters.
- Refuge staff would comply with all Federal, State, and local pesticide use laws and regulations as well as Service pesticide-related policies. For example, Refuge staff would use application equipment and apply rates for the specific pest(s) identified on the pesticide label as required under FIFRA.
- Before each treatment season and prior to mixing or applying any product for the first time each

season, all applicators would review the labels, MSDSs, and Pesticide Use Proposal (PUPs) for each pesticide, determining the target pest, appropriate mix rate(s), PPE, and other requirements listed on the pesticide label.

- A 1‟ no-spray buffer from the water‟s edge would be used, where applicable, and it does not detrimentally influence effective control of pest species.
- Use low impact herbicide application techniques (e.g., spot treatment, cut stump, oil basal, Thinvert system applications) rather than broadcast foliar applications (e.g., boom sprayer, other larger tank wand applications), where practical.
- Use low volume rather than high volume foliar applications where low impact methods above are not feasible or practical, to maximize herbicide effectiveness and ensure correct and uniform application rates.
- Applicators would use and adjust spray equipment to apply the coarsest droplet size spectrum with optimal coverage of the target species while reducing drift.
- Applicators would use the largest droplet size that results in uniform coverage.
- Applicators would use drift reduction technologies such as low-drift nozzles, where possible.
- Where possible, spraying would occur during low (average<7mph and preferably 3-5 mph) and consistent direction wind conditions with moderate temperatures (typically <85 $^{o}$F).
- Where possible, applicators would avoid spraying during inversion conditions (often associated with calm and very low wind conditions) that can cause large-scale herbicide drift to nontarget areas.
- Equipment would be calibrated regularly to ensure that the proper rate of pesticide is applied to the target area or species.
- Spray applications would be made at the lowest height for uniform coverage of target pests to minimize/eliminate potential drift.
- If windy conditions frequently occur during afternoons, spraying (especially boom treatments) would typically be conducted during early morning hours.
- Spray applications would not be conducted on days with >30% forecast for rain within 6 hours, except for pesticides that are rapidly rain fast (e.g., glyphosate in 1 hour) to minimize/eliminate potential runoff.
- Where possible, applicators would use drift retardant adjuvants during spray applications, especially adjacent to sensitive areas.
- Where possible, applicators would use a nontoxic dye to aid in identifying target area treated as well as potential over spray or drift. A dye can also aid in detecting equipment leaks. If a leak is discovered, the application would be stopped until repairs can be made to the sprayer.
- For pesticide uses associated with facilities management, buffers, as appropriate, would be used to protect sensitive habitats, especially wetlands and other aquatic habitats.
- When drift cannot be sufficiently reduced through altering equipment set up and application techniques, buffer zones may be identified to protect sensitive areas downwind of applications. Refuge staff would only apply adjacent to sensitive areas when the wind is blowing the opposite direction.
- Applicators would utilize scouting for early detection of pests to eliminate unnecessary pesticide applications.
- Refuge staff would consider timing of application so native plants are protected (e.g., senescence) while effectively treating invasive plants.
- Rinsate from cleaning spray equipment after application would be recaptured and reused or applied to an appropriate pest plant infestation.

- Application equipment (e.g., sprayer, ATV, tractor) would be thoroughly cleaned and PPE would be removed/disposed of on-site by applicators after treatments to eliminate the potential spread of pests to un-infested areas.

## 6.0 Safety

### 6.1 Personal Protective Equipment

All applicators would wear the specific personal protective equipment (PPE) identified on the pesticide label. The appropriate PPE will be worn at all times during handling, mixing, and applying. PPE can include the following: disposable (e.g., Tyvek) or laundered coveralls; gloves (latex, rubber, or nitrile); rubber boots; and/or an NIOSH-approved respirator. Because exposure to concentrated product is usually greatest during mixing, extra care should be taken while preparing pesticide solutions. Persons mixing these solutions can be best protected if they wear long gloves, an apron, footwear, and a face shield.

Coveralls and other protective clothing used during an application would be laundered separately from other laundry items. Transporting, storing, handling, mixing and disposing of pesticide containers will be consistent with label requirements, USEPA and OSHA requirements, and Service policy.

If a respirator is necessary for a pesticide use, then the following requirements would be met in accordance with Service safety policy: a written Respirator Program, fit testing, physical examination (including pulmonary function and blood work for contaminants), and proper storage of the respirator.

### 6.2 Notification

The restricted entry interval (REI) is the time period required after the application at which point someone may safely enter a treated area without PPE. Refuge staff, authorized management agents of the Service, volunteers, and members of the public who could be in or near a pesticide treated area within the stated re-entry time period on the label would be notified about treatment areas. Posting would occur at any site where individuals might inadvertently become exposed to a pesticide during other activities on the Refuge. Where required by the label and/or State-specific regulations, sites would also be posted on its perimeter and at other likely locations of entry. Refuge staff would also notify appropriate private property owners of an intended application, including any private individuals have requested notification. Special efforts would be made to contact nearby individuals who are beekeepers or who have expressed chemical sensitivities.

### 6.3 Medical Surveillance

Medical surveillance may be required for Service personnel and approved volunteers who mix, apply, and/or monitor use of pesticides (see 242 FW 7 [Pesticide Users] and 242 FW 4 [Medical Surveillance]). In accordance with 242 FW 7.12A, Service personnel would be medically monitoring if 1 or more of the following criteria is met: exposed or may be exposed to concentrations at or above the published permissible exposure limits or threshold limit values (see 242 FW 4); use pesticides in a manner considered "frequent pesticide use"; or use pesticides in a manner that requires a respirator (see 242 FW 14 for respirator use requirements). In 242 FW7.7A, **"Frequent Pesticide Use"** means when a person applying pesticide handles, mixes, or applies pesticides, with a Health Hazard rating of 3 or higher, for 8 or more hours in any week or 16 or more hours in any 30-day period." Under some circumstances, individuals may be medically monitored

who use pesticides infrequently (see section 7.7), experience an acute exposure (sudden, short term), or use pesticides with a health hazard ranking of 1 or 2. This decision would consider the individual‟s health and fitness level, the pesticide‟s specific health risks, and the potential risks from other pesticide-related activities. Refuge cooperators and other authorized agents (e.g., State and County employees) would be responsible for their own medical monitoring needs and costs.

Standard examinations (at Refuge expense) of appropriate Refuge staff would be provided by the nearest certified occupational health and safety physician as determined by Federal Occupational Health.

### 6.4 Certification and Supervision of Pesticide Applicators

Appropriate Refuge staff or approved volunteers handling, mixing, and/or applying or directly supervising others engaged in pesticide use activities would be trained and State or federally licensed to apply pesticides to Refuge lands or waters. In accordance with 242 FW7.18A and 569 FW 1, certification is required to apply restricted use pesticides based upon USEPA regulations. For safety reasons, all individuals participating in pest management activities with general use pesticides also are encouraged to attend appropriate training or acquire pesticide applicator certification. The certification requirement would be for a commercial or private applicator depending upon the State. New staff unfamiliar with proper procedures for storing, mixing, handling, applying, and disposing of herbicides and containers would receive orientation and training before handling or using any products. Documentation of training would be kept in the files at the Refuge office.

### 6.5 Record Keeping

#### 6.5.1 Labels and material safety data sheets

Pesticide labels and material safety data sheets (MSDSs) would be maintained at the Refuge shop and laminated copies in the mixing area. These documents also would be carried by field applicators, where possible. A written reference (e.g., note pad, chalk board, dry erase board) for each tank to be mixed would be kept in the mixing area for quick reference while mixing is in progress. In addition, approved PUPs stored in the PUPS database typically contain website links (URLs) to pesticide labels and MSDSs.

#### 6.5.2 Pesticide use proposals (PUPs)

A PUP would be prepared for each proposed pesticide use associated with annual pest management on Refuge lands and waters. A PUP would include specific information about the proposed pesticide use including the common and chemical names of the pesticide(s), target pest species, size and location of treatment site(s), application rate(s) and method(s), and federally listed species determinations, where applicable.

In accordance with 30 AM 12 and 7 RM 14, PUPs would be required for the following:

- Uses of pesticides on lands and facilities owned or managed by the Service, including properties managed by Service personnel as a result of the Food Security Act of 1985;
- Service projects by non-Service personnel on Service owned or controlled lands and facilities and other pest management activities that would be conducted by Service personnel; and
- Where the Service would be responsible or provides funds for pest management identified in protective covenants, easements, contracts, or agreements off Service lands.

In accordance with Service guidelines (Director‟s memo [December 12, 2007]), Refuge staff may receive up to 5-year approvals for Washington Office and field reviewed proposed pesticide uses based upon meeting identified criteria including an approved IPM plan, where necessary (see http://www.fws.gov/contaminants/Issues/IPM.cfm). For a refuge, an IPM plan (requirements described herein) can be completed independently or in association with a CCP or HMP if IPM strategies and potential environmental effects are adequately addressed within appropriate NEPA documentation.

PUPs would be created, approved or disapproved, and stored as records in the Pesticide Use Proposal System (PUPS), which is centralized database on the Service‟s intranet (https://systems.fws.gov/pups). Only Service employees can access PUP records in this database.

6.5.3 Pesticide usage

In accordance with 569 FW 1, the Refuge Project Leader would be required to maintain records of all pesticides annually applied on lands or waters under Refuge jurisdiction. This would encompass pesticides applied by other Federal agencies, State and county governments, nongovernment applicators including cooperators and their pest management service providers with Service permission. For clarification, pesticide means all insecticides, insect and plant growth regulators, dessicants, herbicides, fungicides, rodenticides, acaricides, nematicides, fumigants, avicides, and piscicides.

The following usage information can be reported for approved PUPs in the PUPS database:

- Pesticide trade name(s)
- Active ingredient(s)
- Total acres treated
- Total amount of pesticides used (lbs or gallons)
- Total amount of active ingredient(s) used (lbs)
- Target pest(s)
- Efficacy (% control)

To determine whether treatments are efficacious (eradicating, controlling, or containing the target pest) and achieving resource objectives, habitat and/or wildlife response would be monitored both pre- and post-treatment, where possible. Considering available annual funding and staffing, appropriate monitoring data regarding characteristics (attributes) of pest infestations (e.g., area, perimeter, degree of infestation-density, % cover, density) as well as habitat and/or wildlife response to treatments may be collected and stored in a relational database (e.g., Refuge Habitat Management Database), preferably a geo-referenced data management system (e.g., Refuge Lands GIS [RLGIS]) to facilitate data analyses and subsequent reporting. In accordance with adaptive management, data analysis and interpretation would allow treatments to be modified or changed over time, as necessary, to achieve resource objectives considering site-specific conditions in conjunction with habitat and/or wildlife responses. Monitoring could also identify short- and long-term impacts to natural resources and environmental quality associated with IPM treatments in accordance with adaptive management principles identified in 43 CFR 46.145.

## 7.0 Evaluating Pesticide Use Proposals

Pesticides would only be used on Refuge lands for habitat management as well as facilities maintenance after approval of a PUP. In general, proposed pesticide uses on Refuge lands would

only be approved where there would likely be minor, temporary, or localized effects to fish and wildlife species as well as minimal potential to degrade environmental quality. Potential effects to listed and nonlisted species would be evaluated with quantitative ecological risk assessments and other screening measures. Potential effects to environmental quality would be based upon pesticide characteristics of environmental fate (water solubility, soil mobility, soil persistence, and volatilization) and other quantitative screening tools. Ecological risk assessments as well as characteristics of environmental fate and potential to degrade environmental quality for pesticides would be documented in Chemical Profiles (see Section 7.5). These profiles would include threshold values for quantitative measures of ecological risk assessments and screening tools for environmental fate that represent minimal potential effects to species and environmental quality. In general, only pesticide uses with appropriate BMPs (see Section 4.0) for habitat management and facilities maintenance on Refuge lands that would potentially have minor, temporary, or localized effects on Refuge biological and environmental quality (threshold values not exceeded) would be approved.

### 7.1 Overview of Ecological Risk Assessment

An ecological risk assessment process would be used to evaluate potential adverse effects to biological resources as a result of a pesticide(s) proposed for use on Refuge lands. It is an established quantitative and qualitative methodology for comparing and prioritizing risks of pesticides and conveying an estimate of the potential risk for an adverse effect. This quantitative methodology provides an efficient mechanism to integrate best available scientific information regarding hazard, patterns of use (exposure), and dose-response relationships in a manner that is useful for ecological risk decision-making. It would provide an effective way to evaluate potential effects where there is missing or unavailable scientific information (data gaps) to address reasonable, foreseeable adverse effects in the field as required under 40 CFR Part 1502.22. Protocols for ecological risk assessment of pesticide uses on the Refuge were developed through research and established by the US Environmental Protection Agency (2004). Assumptions for these risk assessments are presented in Section 6.2.3.

The toxicological data used in ecological risk assessments are typically results of standardized laboratory studies provided by pesticide registrants to the US Environmental Protection Agency (USEPA) to meet regulatory requirements under the Federal Insecticide, Fungicide and Rodenticide Act of 1996 (FIFRA). These studies assess the acute (lethality) and chronic (reproductive) effects associated with short- and long-term exposure to pesticides on representative species of birds, mammals, freshwater fish, aquatic invertebrates, and terrestrial and aquatic plants. Other effects data publicly available would also be utilized for risk assessment protocols described herein. Toxicity endpoint and environmental fate data are available from a variety of resources. Some of the more useful resources can be found in Section 7.5.

Table E-1. Ecotoxicity tests used to evaluate potential effects to birds, fish, and mammals to establish toxicity endpoints for risk quotient calculations.

| Species Group | Exposure | Measurement endpoint |
|---|---|---|
| Bird | Acute | Median Lethal Concentration ($LC_{50}$) |
| | Chronic | No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[1] |
| Fish | Acute | Median Lethal Concentration ($LC_{50}$) |
| | Chronic | No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[2] |
| Mammal | Acute | Oral Lethal Dose ($LD_{50}$) |
| | Chronic | No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[3] |

[1]Measurement endpoints typically include a variety of reproductive parameters (e.g., number of eggs, number of offspring, eggshell thickness, and number of cracked eggs).
[2]Measurement endpoints for early life stage/life cycle typically include embryo hatch rates, time to hatch, growth, and time to swim-up.
[3]Measurement endpoints include maternal toxicity, teratogenic effects or developmental anomalies, evidence of mutagenicity or genotoxicity, and interference with cellular mechanisms such as DNA synthesis and DNA repair.

### 7.2 Determining Ecological Risk to Fish and Wildlife

The potential for pesticides used on the Refuge to cause direct adverse effects to fish and wildlife would be evaluated using USEPA"s Ecological Risk Assessment Process (US Environmental Protection Agency 2004). This deterministic approach, which is based upon a two-phase process involving estimation of environmental concentrations and then characterization of risk, would be used for ecological risk assessments. This method integrates exposure estimates (estimated environmental concentration [EEC] and toxicological endpoints [e.g., $LC_{50}$ and oral $LD_{50}$]) to evaluate the potential for adverse effects to species groups (birds, mammals, and fish) representative of legal mandates for managing units of the NWRS. This integration is achieved through risk quotients (RQs) calculated by dividing the EEC by acute and chronic toxicity values selected from standardized toxicological endpoints or published effect (Table 1).

$$RQ = EEC/Toxicological\ Endpoint$$

The level of risk associated with direct effects of pesticide use would be characterized by comparing calculated RQs to the appropriate Level of Concern (LOC) established by US Environmental Protection Agency (1998 [Table 2]). The LOC represents a quantitative threshold value for screening potential adverse effects to fish and wildlife resources associated with pesticide use. The following are four exposure-species group scenarios that would be used to characterize ecological risk to fish and wildlife on the Refuge: acute-listed species, acute-nonlisted species, chronic-listed species, and chronic-nonlisted species.

Acute risk would indicate the potential for mortality associated with short-term dietary exposure to pesticides immediately after an application. For characterization of acute risks, median values from $LC_{50}$ and $LD_{50}$ tests would be used as toxicological endpoints for RQ calculations. In contrast, chronic risks would indicate the potential for adverse effects associated with long-term dietary exposure to pesticides from a single application or multiple applications over time (within a season

and over years). For characterization of chronic risks, the no observed concentration (NOAEC) or no observed effect concentration (NOEC) for reproduction would be used as toxicological endpoints for RQ calculations. Where available, the NOAEC would be preferred over a NOEC value.

Listed species are those federally designated as threatened, endangered, or proposed in accordance with the Endangered Species Act of 1973 (16 USC 1531-1544, 87 Stat. 884, as amended-Public Law 93-205). For listed species, potential adverse effects would be assessed at the individual level because loss of individuals from a population could detrimentally impact a species. In contrast, risks to nonlisted species would consider effects at the population level. A RQ<LOC would indicate the proposed pesticide use "may affect, not likely to adversely effect" individuals (listed species) and it would not pose an unacceptable risk for adverse effects to populations (nonlisted species) for each taxonomic group (Table 2). In contrast, a RQ>LOC would indicate a "may affect, likely to adversely affect" for listed species and it would also pose unacceptable ecological risk for adverse effects to nonlisted species.

Table E-2. Presumption of unacceptable risk for birds, fish, and mammals (US EPA 1998).

| Risk Presumption | | Level of Concern | |
|---|---|---|---|
| | | Listed Species | Nonlisted Species |
| Acute | Birds | 0.1 | 0.5 |
| | Fish | 0.05 | 0.5 |
| | Mammals | 0.1 | 0.5 |
| Chronic | Birds | 1.0 | 1.0 |
| | Fish | 1.0 | 1.0 |
| | Mammals | 1.0 | 1.0 |

7.2.1 Environmental exposure

Following release into the environment through application, pesticides would experience several different routes of environmental fate. Pesticides which would be sprayed can move through the air (e.g., particle or vapor drift) and may eventually end up in other parts of the environment such as nontarget vegetation, soil, or water. Pesticides applied directly to the soil may be washed off the soil into nearby bodies of surface water (e.g., surface runoff) or may percolate through the soil to lower soil layers and groundwater (e.g., leaching) (Baker and Miller 1999, Pope et. al. 1999, Butler et. al. 1998, Ramsay et. al. 1995, EXTOXNET 1993*a*). Pesticides which would be injected into the soil may also be subject to the latter two fates. The aforementioned possibilities are by no means complete, but it does indicate movement of pesticides in the environment is very complex with transfers occurring continually among different environmental compartments. In some cases, these exchanges occur not only between areas that are close together, but it also may involve transportation of pesticides over long distances (Barry 2004, Woods 2004).

7.2.1.1 Terrestrial exposure

The estimated environmental concentration (ECC) for exposure to terrestrial wildlife would be quantified using an USEPA screening-level approach (US Environmental Protection Agency 2004). This screening-level approach is not affected by product formulation because it evaluates pesticide active ingredient(s). This approach would vary depending upon the proposed pesticide application method: spray or granular.

7.2.1.1.1 Terrestrial-spray application

For spray applications, exposure would be determined using the Kanaga nomogram method (US Environmental Protection Agency 2005*a*, US Environmental Protection Agency 2004, Pfleeger et al. 1996) through the USEPA"s Terrestrial Residue Exposure model (T-REX) version 1.2.3 (US Environmental Protection Agency 2005*b*). To estimate the maximum (initial) pesticide residue on short grass (<8"m tall) as a general food item category for terrestrial vertebrate species, T-REX input variables would include the following from the pesticide label: maximum pesticide application rate (pounds active ingredient [acid equivalent]/acre) and pesticide half-life (days) in soil. Although there are other food item categories (tall grasses; broadleaf plants and small insects; and fruits, pods, seeds and large insects), short grass was selected because it would yield maximum EECs (240 ppm per lb ai/acre) for worse-case risk assessments. Short grass is not representative of forage for carnivorous species (e.g., raptors), but it would characterize the maximum potential exposure through the diet of avian and mammalian prey items. Consequently, this approach would provide a conservative screening tool for pesticides that do not biomagnify.

For RQ calculations in T-REX, the model would require the weight of surrogate species and Mineau scaling factors (Mineau et. al. 1996). Body weights of bobwhite quail and mallard are included in T-REX by default, but body weights of other organisms (Table E-3) would be entered manually. The Mineau scaling factor accounts for small-bodied bird species that may be more sensitive to pesticide exposure than would be predicted only by body weight. Mineau scaling factors would be entered manually with values ranging from 1 to 1.55 that are unique to a particular pesticide or group of pesticides. If specific information to select a scaling factor is not available, then a value of 1.15 would be used as a default. Alternatively, zero would be entered if it is known that body weight does not influence toxicity of pesticide(s) being assessed. The upper bound estimate output from the T-REX Kanaga nomogram would be used as an EEC for calculation of RQs. This approach would yield a conservative estimate of ecological risk.

Table E-3. Average body weight of selected terrestrial wildlife species frequently used in research to establish toxicological endpoints (Dunning 1984).

| Species | Body Weight (kg) |
|---|---|
| Mammal (15 g) | 0.015 |
| House sparrow | 0.0277 |
| Mammal (35 g) | 0.035 |
| Starling | 0.0823 |
| Red-winged blackbird | 0.0526 |
| Common grackle | 0.114 |
| Japanese quail | 0.178 |
| Bobwhite quail | 0.178 |
| Rat | 0.200 |
| Rock dove (aka pigeon) | 0.542 |
| Mammal (1000 g) | 1.000 |
| Mallard | 1.082 |
| Ring-necked pheasant | 1.135 |

7.2.1.1.2 Terrestrial – granular application

Granular pesticide formulations and pesticide-treated seed would pose a unique route of exposure for avian and mammalian species. The pesticide is applied in discrete units which birds or mammals

might ingest accidentally with food items or intentionally as in the case of some bird species actively seeking and picking up gravel or grit to aid digestion or seed as a food source. Granules may also be consumed by wildlife foraging on earthworms, slugs or other soft-bodied soil organisms to which the granules may adhere.

Terrestrial wildlife RQs for granular formulations or seed treatments would be calculated by dividing the maximum milligrams of active ingredient (ai) exposed (e.g., EEC) on the surface of an area equal to 1 square foot by the appropriate $LD_{50}$ value multiplied by the surrogate"s body weight (Table 3). An adjustment to surface area calculations would be made for broadcast, banded, and in-furrow applications. An adjustment also would be made for applications with and without incorporation of the granules. Without incorporation, it would be assumed that 100% of the granules remain on the soil surface available to foraging birds and mammals. Press wheels push granules flat with the soil surface, but they are not incorporated into the soil. If granules are incorporated in the soil during band or T-band applications or after broadcast applications, it would be assumed only 15% of the applied granules remain available to wildlife. It would be assumed that only 1% of the granules are available on the soil surface following in-furrow applications.

EECs for pesticides applied in granular form and as seed treatments would be determined considering potential ingestion rates of avian or mammalian species (e.g., 10-30% body weight/day). This would provide an estimate of maximum exposure that may occur as a result of granule or seed treatment spills such as those that commonly occur at end rows during application and planting. The availability of granules and seed treatments to terrestrial vertebrates would also be considered by calculating the loading per unit area ($LD_{50}/ft^2$) for comparison to USEPA Level of Concerns (US Environmental Protection Agency 1998). The T-REX version 1.2.3 (US Environmental Protection Agency 2005*b*) contains a submodel which automates Kanaga exposure calculations for granular pesticides and treated seed.

The following formulas will be used to calculate EECs depending upon the type of granular pesticide application:

- In-furrow applications assume a typical value of 1% granules, bait, or seed remain unincorporated.

$$mg\ a.i./ft.^2 = [(lbs.\ product/acre)(\%\ a.i.)(453{,}580\ mg/lbs)(1\%\ exposed))] / \{[(43{,}560\ ft.^2/acre)/(row\ spacing\ (ft.))] / (row\ spacing\ (ft.)\}$$

*or*

$$mg\ a.i./ft^2 = [(lbs\ product/1000\ ft.\ row)(\%\ a.i.)(1000\ ft\ row)(453{,}580\ mg/lb.)(1\%\ exposed)$$

$$EEC = [(mg\ a.i./ft.^2)(\%\ of\ pesticide\ biologically\ available)]$$

- Incorporated banded treatments assume that 15% of granules, bait, seeds are unincorporated.

$$mg\ a.i./ft.^2 = [(lbs.\ product/1000\ row\ ft.)(\%\ a.i.)(453{,}580\ mg/lb.)(1\text{-}\%\ incorporated)] / (1{,}000\ ft.)(band\ width\ (ft.))$$

$$EEC = [(mg\ a.i./ft.^2)(\%\ of\ pesticide\ biologically\ available)]$$

- Broadcast treatment without incorporation assumes 100% of granules, bait, seeds are unincorporated.

$$mg\ a.i./ft.^2 = [(lbs.\ product/acre)(\%\ a.i.)(453{,}590\ mg/lb.)] / (43{,}560\ ft.^2/acre)$$

$$EEC = [(mg\ a.i./ft.^2)(\%\ of\ pesticide\ biologically\ available)]$$

Where:

- *% of pesticide biologically available = 100% without species specific ingestion rates*
- *Conversion for calculating mg a.i./ft.$^2$ using ounces: 453,580 mg/lb. /16 = 28,349 mg/oz.*

The following equation would used to calculate a RQ based on the EEC calculated by one of the above equations. The EEC would divided by the surrogate $LD_{50}$ toxicological endpoint multiplied by the body weight (Table 3) of the surrogate.

$$RQ = EEC / [LD_{50}\ (mg/kg) * body\ weight\ (kg)]$$

As with other risk assessments, a RQ>LOC would be a presumption of unacceptable ecological risk. A RQ<LOC would be a presumption of acceptable risk with only minor, temporary, or localized effects to species.

7.2.1.2 Aquatic exposure

Exposures to aquatic habitats (e.g., wetlands, meadows, ephemeral pools, water delivery ditches) would be evaluated separately for ground-based pesticide treatments of habitats managed for fish and wildlife compared with cropland/facilities maintenance. The primary exposure pathway for aquatic organisms from any ground-based treatments likely would be particle drift during the pesticide application. However, different exposure scenarios would be necessary as a result of contrasting application equipment and techniques as well as pesticides used to control pests on agricultural lands and facilities maintenance (e.g., roadsides, parking lots, trails) compared with other managed habitats on the Refuge. In addition, pesticide applications may be done <25‟of the high water mark of aquatic habitats for habitat management treatments; whereas, no-spray buffers (≥25‟) would be used for facilities maintenance treatments.

7.2.1.2.1 Habitat treatments

For the worst-case exposure scenario to nontarget aquatic habitats, EECs (Table 4) would be would be derived from Urban and Cook (1986) that assumes an intentional overspray to an entire, nontarget water body (1-foot depth) from a treatment <25‟ from the high water mark using the max application rate (acid basis [see above]). However, use of BMPs for applying pesticides (see Section 4.2) would likely minimize/eliminate potential drift to nontarget aquatic habitats during actual treatments. If there would be unacceptable (acute or chronic) risk to fish and wildlife with the simulated 100% overspray (RQ>LOC), then the proposed pesticide use may be disapproved or the PUP would be approved at a lower application rate to minimize/eliminate unacceptable risk to aquatic organisms (RQ=LOC).

Table E.4. Estimated Environmental Concentrations (ppb) of pesticides in aquatic habitats (1" depth) immediately after direct application (Urban and Cook 1986).

| Lbs/acre | EEC (ppb) |
|---|---|
| 0.10 | 36.7 |
| 0.20 | 73.5 |
| 0.25 | 91.9 |
| 0.30 | 110.2 |
| 0.40 | 147.0 |
| 0.50 | 183.7 |
| 0.75 | 275.6 |
| 1.00 | 367.5 |
| 1.25 | 459.7 |
| 1.50 | 551.6 |
| 1.75 | 643.5 |
| 2.00 | 735.7 |
| 2.25 | 827.6 |
| 2.50 | 919.4 |
| 3.00 | 1103.5 |
| 4.00 | 1471.4 |
| 5.00 | 1839 |
| 6.00 | 2207 |
| 7.00 | 2575 |
| 8.00 | 2943 |
| 9.00 | 3311 |
| 10.00 | 3678 |

7.2.1.2.2 Facilities maintenance treatments

Field drift studies conducted by the Spray Drift Task Force, which is a joint project of several agricultural chemical businesses, were used to develop a generic spray drift database. From this database, the AgDRIFT computer model was created to satisfy USEPA pesticide registration spray drift data requirements and as a scientific basis to evaluate off-target movement of pesticides from particle drift and assess potential effects of exposure to wildlife. Several versions of the computer model have been developed (i.e., v2.01 through v2.10). The Spray Drift Task Force AgDRIFT® model version 2.01 (SDTF 2003, AgDRIFT 2001) would be used to derive EECs resulting from drift of pesticides to Refuge aquatic resources from ground-based pesticide applications >25" from the high water mark. The Spray Drift Task Force AgDRIFT model is publicly available at http://www.agdrift.com. At this website, click "AgDRIFT 2.0" and then click "Download Now" and follow the instructions to obtain the computer model.

The AgDRIFT model is composed of submodels called tiers. Tier I Ground submodel would be used to assess ground-based applications of pesticides. Tier outputs (EECs) would be calculated with AgDRIFT using the following input variables: max application rate (acid basis [see above]), low boom (20"), fine to medium droplet size, EPA-defined wetland, and a ≥25-foot distance (buffer) from treated area to water.

### 7.2.2 Use of information on effects of biological control agents, pesticides, degradates, and adjuvants

NEPA documents regarding biological and other environmental effects of biological control agents, pesticides, degradates, and adjuvants prepared by another Federal agency, where the scope would be relevant to evaluation of effects from pesticide uses on Refuge lands, would be reviewed. Possible source agencies for such NEPA documents would include the Bureau of Land Management, US Forest Service, National Park Service, US Department of Agriculture-Animal and Plant Health Inspection Service, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s). Incorporating by reference (40 CFR 1502.21) is a technique used to avoid redundancies in analysis. It also would reduce the bulk of a Service NEPA document, which only would identify the documents that are incorporated by reference. In addition, relevant portions would be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of relevance of the referenced material to the current analysis.

In accordance with the requirements set forth in 43 CFR 46.135, the Service would specifically incorporate through reference ecological risk assessments prepared by the US Forest Service (http://www.fs.fed.us/r6/invasiveplant-eis/Risk-Assessments/Herbicides-Analyzed-InvPlant-EIS.htm) and Bureau of Land Management (http://www.blm.gov/wo/st/en/prog/more/veg_eis.html). These risk assessments and associated documentation also are available in total with the administrative record for the Final Environmental Impact Statement entitled *Pacific Northwest Region Invasive Plant Program – Preventing and Managing Invasive Plants* (US Forest Service 2005) and *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic EIS (PEIS)* (Bureau of Land Management 2007). In accordance with 43 CRF 46.120(d), use of existing NEPA documents by supplementing, tiering to, incorporating by reference, or adopting
previous NEPA environmental analyses would avoid redundancy and unnecessary paperwork.

As a basis for completing "Chemical Profiles" for approving or disapproving Refuge PUPs, ecological risk assessments for the following herbicide and adjuvant uses prepared by the US Forest Service would be incorporated by reference:

- 2,4-D
- Chlorosulfuron
- Clopyralid
- Dicamba
- Glyphosate
- Imazapic
- Imazapyr
- Metsulfuron methyl
- Picloram
- Sethoxydim
- Sulfometuron methyl
- Triclopyr
- Nonylphenol polyethylate (NPE) based surfactants

As a basis for completing "Chemical Profiles" for approving or disapproving Refuge PUPs, ecological risk assessments for the following herbicide uses as well as evaluation of risks associated

with pesticide degradates and adjuvants prepared by the Bureau of Land Management would be incorporated by reference:

- Bromacil
- Chlorsulfuron
- Diflufenzopyr
- Diquat
- Diuron
- Fluridone
- Imazapic
- Overdrive (diflufenzopyr and dicamba)
- Sulfometuron methyl
- Tebuthiuron
- Pesticide degradates and adjuvants (*Appendix D – Evaluation of risks from degradates, polyoxyethylene-amine (POEA) and R-11, and endocrine disrupting chemicals*)

7.2.3 Assumptions for ecological risk assessments

There are a number of assumptions involved with the ecological risk assessment process for terrestrial and aquatic organisms associated with utilization of the US Environmental Protection Agency‟s (2004) process. These assumptions may be risk neutral or may lead to an over- or under-estimation of risk from pesticide exposure depending upon site-specific conditions. The following describes these assumptions, their application to the conditions typically encountered, and whether or not they may lead to recommendations that are risk neutral, underestimate, or overestimate ecological risk from potential pesticide exposure.

- Indirect effects would not be evaluated by ecological risk assessments. These effects include the mechanisms of indirect exposure to pesticides: consuming prey items (fish, birds, or small mammals), reductions in the availability of prey items, and disturbance associated with pesticide application activities.
- Exposure to a pesticide product can be assessed based upon the active ingredient. However, exposure to a chemical mixture (pesticide formulation) may result in effects that are similar or substantially different compared to only the active ingredient. Nontarget organisms may be exposed directly to the pesticide formulation or only various constituents of the formulation as they dissipate and partition in the environment. If toxicological information for both the active ingredient and formulated product are available, then data representing the greatest potential toxicity would be selected for use in the risk assessment process (US Environmental Protection Agency 2004). As a result, this conservative approach may lead to an overestimation of risk characterization from pesticide exposure.
- Because toxicity tests with listed or candidate species or closely related species are not available, data for surrogate species would be most often used for risk assessments. Specifically, bobwhite quail and mallard duck are the most frequently used surrogates for evaluating potential toxicity to federally listed avian species. Bluegill sunfish, rainbow trout, and fathead minnow are the most common surrogates for evaluating toxicity for freshwater fishes. However, sheep‟s head minnow can be an appropriate surrogate marine species for coastal environments. Rats and mice are the most common surrogates for evaluating toxicity for mammals. Interspecies sensitivity is a major source of uncertainty in pesticide assessments. As a result of this uncertainty, data is selected for the most sensitive species tested within a taxonomic group (birds, fish, and mammals) given the quality of the data is acceptable. If additional toxicity data for more species of organisms in a particular group are available, the selected data will not be limited to the species previously listed as common surrogates.

- The Kanaga nomogram outputs maximum EEC values that may be used to calculate an average daily concentration over a specified interval of time, which is referred to as a time-weighted-average (TWA). The maximum EEC would be selected as the exposure input for both acute and chronic risk assessments in the screening-level evaluations. The initial or maximum EEC derived from the Kanaga nomogram represents the maximum expected instantaneous or acute exposure to a pesticide. Acute toxicity endpoints are determined using a single exposure to a known pesticide concentration typically for 48 to 96 hours. This value is assumed to represent ecological risk from acute exposure to a pesticide. On the other hand, chronic risk to pesticide exposure is a function of pesticide concentration and duration of exposure to the pesticide. An organism‟s response to chronic pesticide exposure may result from either the concentration of the pesticide, length of exposure, or some combination of both factors. Standardized tests for chronic toxicity typically involve exposing an organism to several different pesticide concentrations for a specified length of time (days, weeks, months, years or generations). For example, avian reproduction tests include a 10-week exposure phase. Because a single length of time is used in the test, time response data is usually not available for inclusion into risk assessments. Without time response data it is difficult to determine the concentration which elicited a toxicological response.
- Using maximum EECs for chronic risk estimates may result in an overestimate of risk, particularly for compounds that dissipate rapidly. Conversely, using TWAs for chronic risk estimates may underestimate risk if it is the concentration rather than the duration of exposure that is primarily responsible for the observed adverse effect. The maximum EEC would be used for chronic risk assessments although it may result in an overestimate of risk. TWAs may be used for chronic risk assessments, but they will be applied judiciously considering the potential for an underestimate or overestimate of risk. For example, the number of days exposure exceeds a Level of Concern may influence the suitability of a pesticide use. The greater the number of days the EEC exceeds the Level of Concern translates into greater the ecological risk. This is a qualitative assessment, and is subject to reviewer‟s expertise in ecological risk assessment and tolerance for risk.
- The length of time used to calculate the TWA can have a substantial effect on the exposure estimates and there is no standard method for determining the appropriate duration for this estimate. The T-REX model assumes a 21-week exposure period, which is equivalent to avian reproductive studies designed to establish a steady-state concentration for bioaccumulative compounds. However, this does not necessarily define the true exposure duration needed to elicit a toxicological response. Pesticides, which do not bioaccumulate, may achieve a steady-state concentration earlier than 21 weeks. The duration of time for calculating TWAs will require justification and it will not exceed the duration of exposure in the chronic toxicity test (approximately 70 days for the standard avian reproduction study). An alternative to using the duration of the chronic toxicity study is to base the TWA on the application interval. In this case, increasing the application interval would suppress both the estimated peak pesticide concentration and the TWA. Another alternative to using TWAs would be to consider the number of days that a chemical is predicted to exceed the LOC.
- Pesticide dissipation is assumed to be first-order in the absence of data suggesting alternative dissipation patterns such as bi-phasic. Field dissipation data would generally be the most pertinent for assessing exposure in terrestrial species that forage on vegetation. However, this data is often not available and it can be misleading particularly if the compound is prone to “wash-off”. Soil half-life is the most common degradation data available. Dissipation or degradation data that would reflect the environmental conditions typical of Refuge lands would be utilized, if available.

- For species found in the water column, it would be assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column.
- Actual habitat requirements of any particular terrestrial species are not considered, and it is assumed that species exclusively and permanently occupy the treated area, or adjacent areas receiving pesticide at rates commensurate with the treatment rate. This assumption would produce a maximum estimate of exposure for risk characterization. This assumption would likely lead to an overestimation of exposure for species that do not permanently and exclusively occupy the treated area (US Environmental Protection Agency 2004).
- Exposure through incidental ingestion of pesticide contaminated soil is not considered in the USEPA risk assessment protocols. Research suggests <15% of the diet can consist of incidentally ingested soil depending upon species and feeding strategy (Beyer et al. 1994). An assessment of pesticide concentrations in soil compared to food item categories in the Kanaga nomogram indicates incidental soil ingestion will not likely increase dietary exposure to pesticides. Inclusion of soil into the diet would effectively reduce the overall dietary concentration compared to the present assumption that the entire diet consists a contaminated food source (Fletcher et al. 1994). An exception to this may be soil-applied pesticides in which exposure from incidental ingestion of soil may increase. Potential for pesticide exposure under this assumption may be underestimated for soil-applied pesticides and overestimated for foliar-applied pesticides. The concentration of a pesticide in soil would likely be less than predicted on food items.
- Exposure through inhalation of pesticides is not considered in the USEPA risk assessment protocols. Such exposure may occur through three potential sources: spray material in droplet form at time of application, vapor phase with the pesticide volatilizing from treated surfaces, and airborne particulates (soil, vegetative matter, and pesticide dusts). The USEPA (1990) reported exposure from inhaling spray droplets at the time of application is not an appreciable route of exposure for birds. According to research on mallards and bobwhite quail, respirable particle size (particles reaching the lung) in birds is limited to maximum diameter of 2 to 5 microns. The spray droplet spectra covering the majority of pesticide application scenarios indicate that less than 1% of the applied material is within the respirable particle size. This route of exposure is further limited because the permissible spray drop size distribution for ground pesticide applications is restricted to ASAE medium or coarser drop size distribution.
- Inhalation of a pesticide in the vapor phase may be another source of exposure for some pesticides under certain conditions. This mechanism of exposure to pesticides occurs post application and it would pertain to those pesticides with a high vapor pressure. The USEPA is currently evaluating protocols for modeling inhalation exposure from pesticides including near-field and near-ground air concentrations based upon equilibrium and kinetics-based models. Risk characterization for exposure with this mechanism is unavailable.
- The effect from exposure to dusts contaminated with the pesticide cannot be assessed generically as partitioning issues related to application site soils and chemical properties of the applied pesticides render the exposure potential from this route highly situation specific.
- Dermal exposure may occur through three potential sources: direct application of spray to terrestrial wildlife in the treated area or within the drift footprint, incidental contact with contaminated vegetation, or contact with contaminated water or soil. Interception of spray and incidental contact with treated substrates may pose risk to avian wildlife (Driver et al. 1991). However, available research related to wildlife dermal contact with pesticides is extremely limited, except dermal toxicity values are common for some mammals used as human surrogates (rats and mice). The USEPA is currently evaluating protocols for modeling dermal exposure. Risk characterization may be underestimated for this route of exposure, particularly with high

risk pesticides such as some organophosphates or carbamate insecticides. If protocols are established by the USEPA for assessing dermal exposure to pesticides, they will be considered for incorporation into pesticide assessment protocols.

- Exposure to a pesticide may occur from consuming surface water, dew or other water on treated surfaces. Water soluble pesticides have potential to dissolve in surface runoff and puddles in a treated area may contain pesticide residues. Similarly, pesticides with lower organic carbon partitioning characteristics and higher solubility in water have a greater potential to dissolve in dew and other water associated with plant surfaces. Estimating the extent to which such pesticide loadings to drinking water occurs is complex and would depend upon the partitioning characteristics of the active ingredient, soils types in the treatment area, and the meteorology of the treatment area. In addition, the use of various water sources by wildlife is highly species-specific. Currently, risk characterization for this exposure mechanism is not available. The USEPA is actively developing protocols to quantify drinking water exposures from puddles and dew. If and when protocols are formally established by the USEPA for assessing exposure to pesticides through drinking water, these protocols will be incorporated into pesticide risk assessment protocols.
- Risk assessments are based upon the assumption that the entire treatment area would be subject to pesticide application at the rates specified on the label. In most cases, there is potential for uneven application of pesticides through such plausible incidents such as changes in calibration of application equipment, spillage, and localized releases at specific areas in or near the treated field that are associated with mixing and handling and application equipment as well as applicator skill. Inappropriate use of pesticides and the occurrence of spills represent a potential underestimate of risk. It is likely not an important factor for risk characterization. All pesticide applicators are required to be certified by the State in which they apply pesticides. Certification training includes the safe storage, transport, handling, and mixing of pesticides, equipment calibration and proper application with annual continuing education.
- The USEPA relies on Fletcher (1994) for setting the assumed pesticide residues in wildlife dietary items. The USEPA (2004) "believes that these residue assumptions reflect a realistic upper-bound residue estimate, although the degree to which this assumption reflects a specific percentile estimate is difficult to quantify". Fletcher"s (1994) research suggests that the pesticide active ingredient residue assumptions used by the USEPA represent a 95$^{th}$ percentile estimate. However, research conducted by Pfleeger et al. (1996) indicates USEPA residue assumptions for short grass was not exceeded. Baehr and Habig (2000) compared USEPA residue assumptions with distributions of measured pesticide residues for the USEPA"s UTAB database. Overall residue selection level will tend to overestimate risk characterization. This is particularly evident when wildlife individuals are likely to have selected a variety of food items acquired from multiple locations. Some food items may be contaminated with pesticide residues whereas others are not contaminated. However, it is important to recognize differences in species feeding behavior. Some species may consume whole above-ground plant material, but others will preferentially select different plant structures. Also, species may preferentially select a food item although multiple food items may be present. Without species specific knowledge regarding foraging behavior characterizing ecological risk other than in general terms is not possible.
- Acute and chronic risk assessments rely on comparisons of wildlife dietary residues with $LC_{50}$ or NOEC values expressed as concentrations of pesticides in laboratory feed. These comparisons assume that ingestion of food items in the field occurs at rates commensurate with those in the laboratory. Although the screening assessment process adjusts dry-weight estimates of food intake to reflect the increased mass in fresh-weight wildlife food intake estimates, it does not allow for gross energy and assimilative efficiency differences between wildlife food items and

laboratory feed. Differences in assimilative efficiency between laboratory and wild diets suggest that current screening assessment methods are not accounting for a potentially important aspect of food requirements.

- There are several other assumptions that can affect nontarget species not considered in the risk assessment process. These include possible additive or synergistic effects from applying two or more pesticides or additives in a single application, co-location of pesticides in the environment, cumulative effects from pesticides with the same mode of action, effects of multiple stressors (e.g., combination of pesticide exposure, adverse abiotic and biotic factors) and behavioral changes induced by exposure to a pesticide. These factors may exist at some level contributing to adverse affects to nontarget species, but they are usually characterized in the published literature in only a general manner limiting their value in the risk assessment process.
- It is assumed that aquatic species exclusively and permanently occupy the water body being assessed. Actual habitat requirements of aquatic species are not considered. With the possible exception of scenarios where pesticides are directly applied to water, it is assumed that no habitat use considerations specific for any species would place the organisms in closer proximity to pesticide use sites. This assumption produces a maximum estimate of exposure or risk characterization. It would likely be realistic for many aquatic species that may be found in aquatic habitats within or in close proximity to treated terrestrial habitats. However, the spatial distribution of wildlife is usually not random because wildlife distributions are often related to habitat requirements of species. Clumped distributions of wildlife may result in an under- or over-estimation of risk depending upon where the initial pesticide concentration occurs relative to the species or species habitat.
- For species found in the water column, it would be assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column. Additional chemical exposure from materials associated with suspended solids or food items is not considered because partitioning onto sediments likely is minimal. Adsorption and bioconcentration occurs at lower levels for many newer pesticides compared with older more persistent bioaccumulative compounds. Pesticides with RQs close to the listed species level of concern, the potential for additional exposure from these routes may be a limitation of risk assessments, where potential pesticide exposure or risk may be underestimated.
- Mass transport losses of pesticide from a water body (except for losses by volatilization, degradation and sediment partitioning) would not be considered for ecological risk assessment. The water body would be assumed to capture all pesticide active ingredients entering as runoff, drift, and adsorbed to eroded soil particles. It would also be assumed that pesticide active ingredient is not lost from the water body by overtopping or flow-through, nor is concentration reduced by dilution. In total, these assumptions would lead to a near maximum possible water-borne concentration. However, this assumption would not account for potential to concentrate pesticide through the evaporative loss. This limitation may have the greatest impact on water bodies with high surface-to-volume ratios such as ephemeral wetlands, where evaporative losses are accentuated and applied pesticides have low rates of degradation and volatilization.
- For acute risk assessments, there would be no averaging time for exposure. An instantaneous peak concentration would be assumed, where instantaneous exposure is sufficient in duration to elicit acute effects comparable to those observed over more protracted exposure periods (typically 48 to 96 hours) tested in the laboratory. In the absence of data regarding time-to-toxic event, analyses and latent responses to instantaneous exposure, risk would likely be overestimated.
- For chronic exposure risk assessments, the averaging times considered for exposure are commensurate with the duration of invertebrate life-cycle or fish-early life stage tests (e.g., 21-28

days and 56-60 days, respectively). Response profiles (time to effect and latency of effect) to pesticides likely vary widely with mode of action and species and should be evaluated on a case-by-case basis as available data allow. Nevertheless, because the USEPA relies on chronic exposure toxicity endpoints based on a finding of no observed effect, the potential for any latent toxicity effects or averaging time assumptions to alter the results of an acceptable chronic risk assessment prediction is limited. The extent to which duration of exposure from water-borne concentrations overestimate or underestimate actual exposure depends on several factors. These include the following: localized meteorological conditions, runoff characteristics of the watershed (e.g., soils, topography), the hydrological characteristics of receiving waters, environmental fate of the pesticide active ingredient, and the method of pesticide application. It should also be understood that chronic effects studies are performed using a method that holds water concentration in a steady state. This method is not likely to reflect conditions associated with pesticide runoff. Pesticide concentrations in the field increase and decrease in surface water on a cycle influenced by rainfall, pesticide use patterns, and degradation rates. As a result of the dependency of this assumption on several undefined variables, risk associated with chronic exposure may in some situations underestimate risk and overestimate risk in others.

- There are several other factors that can affect nontarget species not considered in the risk assessment process. These would include the following: possible additive or synergistic effects from applying two or more pesticides or additives in a single application, co-location of pesticides in the environment, cumulative effects from pesticides with the same mode of action, effects of multiple stressors (e.g., combination of pesticide exposure, adverse abiotic [not pesticides] and biotic factors), and sub-lethal effects such as behavioral changes induced by exposure to a pesticide. These factors may exist at some level contributing to adverse affects to nontarget species, but they are not routinely assessed by regulatory agencies. Therefore, information on the factors is not extensive limiting their value for the risk assessment process. As this type of information becomes available, it would be included, either quantitatively or qualitatively, in this risk assessment process.
- USEPA is required by the Food Quality Protection Act to assess the cumulative risks of pesticides that share common mechanisms of toxicity, or act the same within an organism. Currently, USEPA has identified four groups of pesticides that have a common mechanism of toxicity requiring cumulative risk assessments. These four groups are: the organophosphate insecticides, N-methyl carbamate insecticides, triazine herbicides, and chloroacetanilide herbicides.

### 7.3 Pesticide Mixtures and Degradates

Pesticide products are usually a formulation of several components generally categorized as active ingredients and inert or other ingredients. The term active ingredient is defined by the FIFRA as preventing, destroying, repelling, or mitigating the effects of a pest, or it is a plant regulator, defoliant, desiccant, or nitrogen stabilizer. In accordance with FIFRA, the active ingredient(s) must be identified by name(s) on the pesticide label along with its relative composition expressed in percentage(s) by weight. In contrast, inert ingredient(s) are not intended to affect a target pest. Their role in the pesticide formulation is to act as a solvent (keep the active ingredient is a liquid phase), an emulsifying or suspending agent (keep the active ingredient from separating out of solution), or a carrier such as clay in which the active ingredient is impregnated on the clay particle in dry formulations. For example, if isopropyl alcohol would be used as a solvent in a pesticide formulation, then it would be considered an inert ingredient. FIFRA only requires that inert ingredients identified as hazardous and associated percent composition, and the total percentage of

all inert ingredients must be declared on a product label. Inert ingredients that are not classified as hazardous are not required to be identified.

The USEPA (September 1997) issued Pesticide Regulation Notice 97-6 which encouraged manufacturers, formulators, producers, and registrants of pesticide products to voluntarily substitute the term "other ingredients" for "inert ingredients" in the ingredient statement. This change recognized that all components in a pesticide formulation potentially could elicit or contribute to an adverse effect on nontarget organisms and, therefore, are not necessarily inert. Whether referred to as "inerts" or "other ingredients," these constituents within a pesticide product have the potential to affect species or environmental quality. The USEPA categorizes regulated inert ingredients into the following four lists (http://www.epa.gov/opprd001/inerts/index.html):

- List 1 – Inert Ingredients of Toxicological Concern
- List 2 – Potentially Toxic Inert Ingredients
- List 3 – Inerts of Unknown Toxicity
- List 4 – Inerts of Minimal Toxicity

Several of the List 4 compounds are naturally-occurring earthen materials (e.g., clay materials, simple salts) that would not elicit toxicological response at applied concentrations. However, some of the inerts (particularly the List 3 compounds and unlisted compounds) may have moderate to high potential toxicity to aquatic species based on MSDSs or published data.

Comprehensively assessing potential effects to nontarget fish, wildlife, plants, and/or their habitats from pesticide use is a complex task. It would be preferable to assess the cumulative effects from exposure to the active ingredient, its degradates, and inert ingredients as well as other active ingredients in the spray mixture. However, it would only be feasible to conduct deterministic risk assessments for each component in the spray mixture singly. Limited scientific information is available regarding ecological effects (additive or synergistic) from chemical mixtures that typically rely upon broadly encompassing assumptions. For example, the US Forest Service (2005) found that mixtures of pesticides used in land (forest) management likely would not cause additive or synergistic effects to nontarget species based upon a review of scientific literature regarding toxicological effects and interactions of agricultural chemicals (ATSDR 2004). Moreover, information on inert ingredients, adjuvants, and degradates is often limited by the availability of and access to reliable toxicological data for these constituents.

Toxicological information regarding "other ingredients" may be available from sources such as the following:

- TOMES (a proprietary toxicological database including USEPA‟s IRIS, the Hazardous Substance Data Bank, the Registry of Toxic Effects of Chemical Substances [RTECS]).
- USEPA‟s ECOTOX database, which includes AQUIRE (a database containing scientific papers published on the toxic effects of chemicals to aquatic organisms).
- TOXLINE (a literature searching tool).
- Material Safety Data Sheets (MSDSs) from pesticide suppliers.
- Other sources such as the Farm Chemicals Handbook.

Because there is a lack of specific inert toxicological data, inert(s) in a pesticide may cause adverse ecological effects. However, inert ingredients typically represent only a small percentage of the pesticide spray mixture, and it would be assumed that negligible effects would be expected to result from inert ingredient(s).

Although the potential effects of degradates should be considered when selecting a pesticide, it is beyond the scope of this assessment process to consider all possible breakdown chemicals of the various product formulations containing an active ingredient. Degradates may be more or less mobile and more or less hazardous in the environment than their parent pesticides (Battaglin et al. 2003). Differences in environmental behavior (e.g., mobility) and toxicity between parent pesticides and degradates would make assessing potential degradate effects extremely difficult. For example, a less toxic and more mobile, bioaccumulative, or persistent degradate may have potentially greater effects on species and/or degrade environmental quality. The lack of data on the toxicity of degradates for many pesticides would represent a source of uncertainty for assessing risk.

An USEPA-approved label specifies whether a product can be mixed with one or more pesticides. Without product-specific toxicological data, it would not possible to quantify the potential effects of these mixtures. In addition, a quantitative analysis could only be conducted if reliable scientific information allowed a determination of whether the joint action of a mixture would be additive, synergistic, or antagonistic. Such information would not likely exist unless the mode of action would be common among the chemicals and receptors. Moreover, the composition of and exposure to mixtures would be highly site- and/or time-specific and, therefore, it would be nearly impossible to assess potential effects to species and environmental quality.

To minimize or eliminate potential negative effects associated with applying two or more pesticides as a mixture, the use would be conducted in accordance with the labeling requirements. Labels for two or more pesticides applied as a mixture should be completely reviewed, where products with the least potential for negative effects would be selected for use on the Refuge. This is especially relevant when a mixture would be applied in a manner that may already have the potential for an effect(s) associated with an individual pesticide (e.g., runoff to ponds in sandy watersheds). Use of a tank mix under these conditions would increase the level of uncertainty in terms of risk to species or potential to degrade environmental quality.

Adjuvants generally function to enhance or prolong the activity of pesticide. For terrestrial herbicides, adjuvants aid in the absorption into plant tissue. Adjuvant is a broad term that generally applies to surfactants, selected oils, anti-foaming agents, buffering compounds, drift control agents, compatibility agents, stickers, and spreaders. Adjuvants are not under the same registration requirements as pesticides and the USEPA does not register or approve the labeling of spray adjuvants. Individual pesticide labels identify types of adjuvants approved for use with it. In general, adjuvants compose a relatively small portion of the volume of pesticides applied. Selection of adjuvants with limited toxicity and low volumes would be recommended to reduce the potential for the adjuvant to influence the toxicity of the pesticide.

### 7.4 Determining Effects to Soil and Water Quality

The approval process for pesticide uses would consider potential to degrade water quality on and off Refuge lands. A pesticide can only affect water quality through movement away from the treatment site. After application, pesticide mobilization can be characterized by one or more of the following (Kerle et al. 1996):

- Attach (sorb) to soil, vegetation, or other surfaces and remain at or near the treated area;
- Attach to soil and move off-site through erosion from run-off or wind;
- Dissolve in water that can be subjected to run-off or leaching.

As an initial screening tool, selected chemical characteristics and rating criteria for a pesticide can be evaluated to assess potential to enter ground and/or surface waters. These would include the following: persistence, sorption coefficient ($K_{oc}$), groundwater ubiquity score (GUS), and solubility.

Persistence, which is expressed as half-life ($t_{½}$), represents the length of time required for 50% of the deposited pesticide to degrade (completely or partially). Persistence in the soil can be categorized as the following: nonpersistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et. al. 1996). Half-life data is usually available for aquatic and terrestrial environments.

Another measure of pesticide persistence is dissipation time ($DT_{50}$). It represents the time required for 50% of the deposited pesticide to degrade and move from a treated site; whereas, half-life describes the rate for degradation only. As for half-life, units of dissipation time are usually expressed in days. Field or foliar dissipation time is the preferred data for use to estimate pesticide concentrations in the environment. However, soil half-life is the most common persistence data cited in published literature. If field or foliar dissipation data is not available, soil half-life data may be used. The average or representative half-life value of most important degradation mechanism will be selected for quantitative analysis for both terrestrial and aquatic environments.

Mobility of a pesticide is a function of how strongly it is adsorbed to soil particles and organic matter, its solubility in water, and its persistence in the environment. Pesticides strongly adsorbed to soil particles, relatively insoluble in water, and not environmentally persistent would be less likely to move across the soil surface into surface waters or to leach through the soil profile and contaminate groundwater. Conversely, pesticides that are not strongly adsorbed to soil particles, are highly water soluble, and are persistent in the environment would have greater potential to move from the application site (off-site movement).

The degree of pesticide adsorption to soil particles and organic matter (Kerle et. al. 1996) is expressed as the soil adsorption coefficient ($K_{oc}$). The soil adsorption coefficient is measured as micrograms of pesticide per gram of soil (µg/g) that can range from near zero to the thousands. Pesticides with higher Koc values are strongly sorbed to soil and, therefore, would be less subject to movement.

Water solubility describes the amount of pesticide that will dissolve in a known quantity of water. The water solubility of a pesticide is expressed as milligrams of pesticide dissolved in a liter of water (mg/l or ppm). Pesticide with solubility <0.1 ppm are virtually insoluble in water, 100-1000 ppm are moderately soluble, and >10,000 ppm highly soluble (US Geological Survey 2000). As pesticide solubility increases, there would be greater potential for off-site movement.

The Groundwater Ubiquity Score (GUS) is a quantitative screening tool to estimate a pesticide"s potential to move in the environment. It utilizes soil persistence and adsorption coefficients in the following formula.

$$GUS = \log_{10}(t_{½}) \times [4 - \log_{10}(K_{oc})]$$

The potential pesticide movement rating would be based upon its GUS value. Pesticides with a GUS <0.1 would considered to have an extremely low potential to move toward groundwater. Values of 1.0-2.0 would be low, 2.0-3.0 would be moderate, 3.0-4.0 would be high, and >4.0 would have a very high potential to move toward groundwater.

Water solubility describes the amount of pesticide dissolving in a specific quantity of water, where it is usually measured as mg/l or parts per million (ppm). Solubility is useful as a comparative measure because pesticides with higher values are more likely to move by run-off or leaching. GUS, water solubility, $t_{½}$, and $K_{oc}$ values are available for selected pesticides from the OSU Extension Pesticide Properties Database at http://npic.orst.edu/ppdmove.htm. Many of the values in this database were derived from the SCS/ARS/CES Pesticide Properties Database for Environmental Decision Making (Wauchope et al. 1992).

Soil properties influence the fate of pesticides in the environment. The following six properties are mostly likely to affect pesticide degradation and the potential for pesticides to move off-site by leaching (vertical movement through the soil) or runoff (lateral movement across the soil surface).

- Permeability is the rate of water movement vertically through the soil. It is affected by soil texture and structure. Coarse textured soils (e.g., high sand content) have a larger pore size and they are generally more permeable than fine textured soils (i.e., high clay content). The more permeable soils would have a greater potential for pesticides to move vertically down through the soil profile. Soil permeability rates (inches/hour) are usually available in county soil survey reports.
- Soil texture describes the relative percentage of sand, silt, and clay. In general, greater clay content with smaller the pore size would lower the likelihood and rate water that would move through the soil profile. Clay also serves to adsorb (bind) pesticides to soil particles. Soils with high clay content would adsorb more pesticide than soils with relatively low clay content. In contrast, sandy soils with coarser texture and lower water holding capacity would have a greater potential for water to leach through them.
- Soil structure describes soil aggregation. Soils with a well developed soil structure have looser, more aggregated, structure that would be less likely to be compacted. Both characteristics would allow for less restricted flow of water through the soil profile resulting in greater infiltration.
- Organic matter would be the single most important factor affecting pesticide adsorption in soils. Many pesticides are adsorbed to organic matter which would reduce their rate of downward movement through the soil profile. Also, soils high in organic matter would tend to hold more water, which may make less water available for leaching.
- Soil moisture affects how fast water would move through the soil. If soils are already wet or saturated before rainfall or irrigation, excess moisture would runoff rather than infiltrate into the soil profile. Soil moisture also would influence microbial and chemical activity in soil, which effects pesticide degradation.
- Soil pH would influence chemical reactions that occur in the soil which in turn determines whether or not a pesticide will degrade, rate of degradation, and, in some instances, which degradation products are produced.

Based upon the aforementioned properties, soils most vulnerable to groundwater contamination would be sandy soils with low organic matter. In contrast, the least vulnerable soils would be well-drained clayey soils with high organic matter. Consequently, pesticides with the lowest potential for movement in conjunction with appropriate best management practices (see below) would be used in an IPM framework to treat pests while minimizing effects to nontarget biota and protecting environmental quality.

Along with soil properties, the potential for a pesticide to affect water quality through run-off and leaching would consider site-specific environmental and abiotic conditions including rainfall, water table conditions, and topography (Huddleston 1996).

- Water is necessary to separate pesticides from soil. This can occur in two basic ways. Pesticides that are soluble move easily with runoff water. Pesticide-laden soil particles can be dislodged and transported from the application site in runoff. The concentration of pesticides in the surface runoff would be greatest for the first runoff event following treatment. The rainfall intensity and route of water infiltration into soil, to a large extent, determine pesticide concentrations and losses in surface runoff. The timing of the rainfall after application also would have an effect. Rainfall interacts with pesticides at a shallow soil depth (¼ to ½ inch), which is called the mixing zone (Baker and Miller 1999). The pesticide/water mixture in the mixing zone would tend to leach down into the soil or runoff depending upon how quickly the soil surface becomes saturated and how rapidly water can infiltrate into the soil. Leaching would decrease the amount of pesticide available near the soil surface (mixing zone) to runoff during the initial rainfall event following application and subsequent rainfall events.
- Terrain slope would affect the potential for surface runoff and the intensity of runoff. Steeper slopes would have greater potential for runoff following a rainfall event. In contrast, soils that are relatively flat would have little potential for runoff, except during intense rainfall events. In addition, soils in lower areas would be more susceptible to leaching as a result of receiving excessive water from surrounding higher elevations.
- Depth to groundwater would be an important factor affecting the potential for pesticides to leach into groundwater. If the distance from the soil surface to the top of the water table is shallow, pesticides would have less distance to travel to reach groundwater. Shallower water tables that persist for longer periods would be more likely to experience groundwater contamination. Soil survey reports are available for individual counties. These reports provide data in tabular format regarding the water table depths and the months during which it is persists. In some situations, a hard pan exists above the water table that would prevent pesticide contamination from leaching.

### 7.5 Determining Effects to Air Quality

Pesticides may volatilize from soil and plant surfaces and move from the treated area into the atmosphere. The potential for a pesticide to volatilize is determined by the pesticide‟s vapor pressure which would be affected by temperature, sorption, soil moisture, and the pesticide‟s water solubility. Vapor pressure is often expressed in mm Hg. To make these numbers easier to compare, vapor pressure may be expressed in exponent form ($I \times 10^{-7}$), where I represents a vapor pressure index. In general, pesticides with I<10 would have a low potential to volatilize; whereas, pesticides with I>1,000 would have a high potential to volatilize (Oregon State University 1996). Vapor pressure values for pesticides are usually available in the pesticide product MSDS or the USDA Agricultural Research Service (ARS) pesticide database.

### 7.6 Preparing a Chemical Profile

The following instructions would be used by Service personnel to complete Chemical Profiles for pesticides. Specifically, profiles would be prepared for pesticide active ingredients (e.g., glyphosate, imazapic) that would be contained in one or more trade name products that are registered and labeled with USEPA. All information fields under each category (e.g., Toxicological Endpoints, Environmental Fate) would be completed for a Chemical Profile. If no information is available for a specific field, then “No data is available in references” would be recorded in the profile. Available scientific information would be used to complete Chemical Profiles. Each entry of scientific information would be shown with applicable references.

Completed Chemical Profiles would provide a structured decision-making process utilizing quantitative assessment/screening tools with threshold values (where appropriate) that would be used

to evaluate potential biological and other environmental effects to Refuge resources. For ecological risk assessments presented in these profiles, the "worst-case scenario" would be evaluated to determine whether a pesticide could be approved for use considering the maximum single application rate specified on pesticide labels for habitat management and croplands/facilities maintenance treatments pertaining to Refuges. Where the "worst-case scenario" likely would only result in minor, temporary, and localized effects to listed and nonlisted species with appropriate BMPs (see Section 5.0), the proposed pesticide"s use in a PUP would have a scientific basis for approval under any application rate specified on the label that is at or below rates evaluated in a Chemical Profile. In some cases, the Chemical Profile would include a lower application rate than the maximum labeled rate in order to protect Refuge resources. As necessary, Chemical Profiles would be periodically updated with new scientific information or as pesticides with the same active ingredient are proposed for use on the Refuge in PUPs.

Throughout this section, threshold values (to prevent or minimize potential biological and environmental effects) would be clearly identified for specific information presented in a completed Chemical Profile. Comparison with these threshold values provides an explicit scientific basis to approve or disapprove PUPs for habitat management and cropland/facilities maintenance on Refuge lands. In general, PUPs would be approved for pesticides with Chemical Profiles where there would be no exceedances of threshold values. However, BMPs are identified for some screening tools that would minimize/eliminate potential effects (exceedance of the threshold value) as a basis for approving PUPs.

**Date:** Service personnel would record the date when the Chemical Profile is completed or updated. Chemical Profiles (e.g., currently approved pesticide use patterns) would be periodically reviewed and updated, as necessary. The most recent review date would be recorded on a profile to document when it was last updated.

**Trade Name(s):** Service personnel would accurately and completely record the trade name(s) from the pesticide label, which includes a suffix that describes the formulation (e.g., WP, DG, EC, L, SP, I, II or 64). The suffix often distinguishes a specific product among several pesticides with the same active ingredient. Service personnel would record a trade name for each pesticide product with the same active ingredient.

**Common chemical name(s):** Service personnel would record the common name(s) listed on the pesticide label or material safety data sheet (MSDS) for an active ingredient. The common name of a pesticide is listed as the active ingredient on the title page of the product label immediately following the trade name, and the MSDS, Section 2: Composition/ Information on Ingredients. A Chemical Profile is completed for each active ingredient.

**Pesticide Type:** Service personnel would record the type of pesticide for an active ingredient as one of the following: herbicide, dessicant, fungicide, fumigant, growth regulator, insecticide, pisicide, or rodenticide.

**EPA Registration Number(s):** This number (EPA Reg. No.) appears on the title page of the label and MSDS, Section 1: Chemical Product and Company Description. It is not the EPA Establishment Number that is usually located near it. Service personnel would record the EPA Reg. No. for each trade name product with an active ingredient based upon PUPs.

**Pesticide Class:** Service personnel would list the general chemical class for the pesticide (active ingredient). For example, malathion is an organophosphate and carbaryl is a carbamate.

**CAS (Chemical Abstract Service) Number:** This number is often located in the second section (Composition/Information on Ingredients) of the MSDS. The MSDS table listing components usually contains this number immediately prior to or following the % composition.

**Other Ingredients:** From the most recent MSDS for the proposed pesticide product(s), Service personnel would include any chemicals in the pesticide formulation not listed as an active ingredient that are described as toxic or hazardous, or regulated under the Superfund Amendments and Reauthorization Act (SARA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Toxic Substances Control Act (TSCA), Occupational Safety and Health Administration (OSHA), State Right-to-Know, or other listed authorities. These are usually found in MSDS sections titled "Hazardous Identifications", "Exposure Control/Personal Protection", and "Regulatory Information". If concentrations of other ingredients are available for any compounds identified as toxic or hazardous, then Service personnel would record this information in the Chemical Profile by trade name. MSDS(s) may be obtained from the manufacturer, manufacturer"s website or from an on-line database maintained by Crop Data Management Systems, Inc. (see list below).

***Toxicological Endpoints***

Toxicological endpoint data would be collected for acute and chronic tests with mammals, birds, and fish. Data would be recorded for species available in the scientific literature. If no data are found for a particular taxonomic group, then "No data available is references" would be recorded as the data entry. Throughout the Chemical Profile, references (including toxicological endpoint data) would be cited using parentheses (#) following the recorded data.

**Mammalian $LD_{50}$:** For test species in the scientific literature, Service personnel would record available data for oral lethal dose ($LD_{50}$) in mg/kg-bw (body weight) or ppm-bw. Most common test species in scientific literature are the rat and mouse. The lowest $LD_{50}$ value found for a rat would be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk to mammals (see Table 1 in Section 7.1).

**Mammalian $LC_{50}$:** For test species in the scientific literature, Service personnel would record available data for dietary lethal concentration ($LC_{50}$) as reported (e.g., mg/kg-diet or ppm-diet). Most common test species in scientific literature are the rat and mouse. The lowest $LC_{50}$ value found for a rat would be used as a toxicological endpoint for diet-based RQ calculations to assess acute risk (see Table 1 in Section 7.1).

**Mammalian Reproduction:** For test species listed in the scientific literature, Service personnel would record the test results (e.g., Lowest Observed Effect Concentration [LOEC], Lowest Observed Effect Level [LOEL], No Observed Adverse Effect Level [NOAEL], No Observed Adverse Effect Concentration [NOAEC]) in mg/kg-bw or mg/kg-diet for reproductive test procedure(s) (e.g., generational studies [preferred], fertility, new born weight). Most common test species available in scientific literature are rats and mice. The lowest NOEC, NOAEC, NOEL, or NOAEL test results found for a rat would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table 1 in Section 7.1).

**Avian $LD_{50}$:** For test species available in the scientific literature, Service personnel would record values for oral lethal dose ($LD_{50}$) in mg/kg-bw or ppm-bw. Most common test species available in scientific literature are the bobwhite quail and mallard. The lowest $LD_{50}$ value found for an avian species would be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk (see Table 1 in Section 7.1).

**Avian $LC_{50}$:** For test species available in the scientific literature, Service personnel would record values for dietary lethal concentration ($LC_{50}$) as reported (e.g., mg/kg-diet or ppm-diet). Most common test species available in scientific literature are the bobwhite quail and mallard. The lowest $LC_{50}$ value found for an avian species would be used as a toxicological endpoint for dietary-based RQ calculations to assess acute risk (see Table 1 in Section 7.1).

**Avian Reproduction:** For test species available in the scientific literature, Service personnel would record test results (e.g., LOEC, LOEL, NOAEC, NOAEL) in mg/kg-bw or mg/kg-diet consumed for reproductive test procedure(s) (e.g., early life cycle, reproductive). Most common test species available in scientific literature are the bobwhite quail and mallard. The lowest NOEC, NOAEC, NOEL, or NOAEL test results found for an avian species would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table 1 in Section 7.1).

**Fish $LC_{50}$:** For test freshwater or marine species listed in the scientific literature, Service personnel would record a $LC_{50}$ in ppm or mg/L. Most common test species available in the scientific literature are the bluegill, rainbow trout, and fathead minnow (marine). Test results for many game species may also be available. The lowest $LC_{50}$ value found for a freshwater fish species would be used as a toxicological endpoint for RQ calculations to assess acute risk (see Table 1 in Section 7.1).

**Fish Early Life Stage (ELS)/Life Cycle:** For test freshwater or marine species available in the scientific literature, Service personnel would record test results (e.g., LOEC, NOAEL, NOAEC, LOAEC) in ppm for test procedure(s) (e.g., early life cycle, life cycle). Most common test species available in the scientific literature are bluegill, rainbow trout, and fathead minnow. Test results for other game species may also be available. The lowest test value found for a fish species (preferably freshwater) would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table 1 in Section 7.1).

**Other:** For test invertebrate as well as nonvascular and vascular plant species available in the scientific literature, Service personnel would record $LC_{50,}$ $LD_{50,}$ LOEC, LOEL, NOAEC, NOAEL, or $EC_{50}$ (environmental concentration) values in ppm or mg/L. Most common test invertebrate species available in scientific literature are the honey bee and the water flea (*Daphnia magna*). Green algae (*Selenastrum capricornutum*) and pondweed (*Lemna minor*) are frequently available test species for aquatic nonvascular and vascular plants, respectively.

**Ecological Incident Reports:** After a site has been treated with pesticide(s), wildlife may be exposed to these chemical(s). When exposure is high relative to the toxicity of the pesticides, wildlife may be killed or visibly harmed (incapacitated). Such events are called ecological incidents. The USEPA maintains a database (Ecological Incident Information System) of ecological incidents. This database stores information extracted from incident reports submitted by various Federal and State agencies and nongovernment organizations. Information included in an incident report is date and location of the incident, type and magnitude of affects observed in various species, use(s) of pesticides known or suspected of contributing to the incident, and results of any chemical residue and cholinesterase activity analyses conducted during the investigation.

Incident reports can play an important role in evaluating the effects of pesticides by supplementing quantitative risk assessments. All incident reports for pesticide(s) with the active ingredient and associated information would be recorded.

***Environmental Fate***

**Water Solubility:** Service personnel would record values for water solubility ($S_w$), which describes the amount of pesticide that dissolves in a known quantity of water. $S_w$ is expressed as mg/L (ppm). Pesticide $S_w$ values would be categorized as one of the following: insoluble <0.1 ppm, moderately soluble = 100 to 1000 ppm, highly soluble >10,000 ppm (US Geological Survey 2000). As pesticide $S_w$ increases, there would be greater potential to degrade water quality through run-off and leaching.

Sw would be used to evaluate potential for bioaccumulation in aquatic species [see **Octanol-Water Partition Coefficient ($K_{ow}$)** below].

**Soil Mobility:** Service personnel would record available values for soil adsorption coefficient ($K_{oc}$ [µg/g]). It provides a measure of a chemical's mobility and leaching potential in soil. $K_{oc}$ values are directly proportional to organic content, clay content, and surface area of the soil. $K_{oc}$ data for a pesticide may be available for a variety of soil types (e.g., clay, loam, sand).

$K_{oc}$ values would be used in evaluating the potential to degrade groundwater by leaching (see **Potential to Move to Groundwater** below).

**Soil Persistence:** Service personnel would record values for soil half-life ($t_{½}$), which represents the length of time (days) required for 50% of the deposited pesticide to degrade (completely or partially) in the soil. Based upon the $t_{½}$ value, soil persistence would be categorized as one of the following: nonpersistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et. al. 1996).

*Threshold for Approving PUPs:*

*If soil $t_{½} \leq 100$ days, then a PUP would be approved without additional BMPs to protect water quality.*
*If soil $t_{½} > 100$ days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the* **Specific Best Management Practices (BMPs) section** *to minimize potential surface run-off and leaching that can degrade water quality:*

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10' and average annual precipitation >12".*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Along with $K_{oc}$, soil $t_{½}$ values would be used in evaluating the potential to degrade groundwater by leaching (see **Potential to Move to Groundwater** below).

**Soil Dissipation:** Dissipation time ($DT_{50}$) represents the time required for 50% of the deposited pesticide to degrade and move from a treated site; whereas, soil $t_{½}$ describes the rate for degradation

only. As for $t_{½}$, units of dissipation time are usually expressed in days. Field dissipation time would be the preferred data for use to estimate pesticide concentrations in the environment because it is based upon field studies compared to soil $t_{½}$, which is derived in a laboratory. However, soil $t_{½}$ is the most common persistence data available in the published literature. If field dissipation data is not available, soil half-life data would be used in a Chemical Profile. The average or representative half-life value of most important degradation mechanism would be selected for quantitative analysis for both terrestrial and aquatic environments.

Based upon the $DT_{50}$ value, environmental persistence in the soil also would be categorized as one of the following: nonpersistent <30 days, moderately persistent = 30-100 days, and persistent >100 days.

*Threshold for Approving PUPs:*

*If soil $DT_{50}$ ≤100 days, then a PUP would be approved without additional BMPs to protect water quality.*
*If soil $DT_{50}$ >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to minimize potential surface run-off and leaching that can degrade water quality:*

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10' and average annual precipitation >12".*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Along with $K_{oc}$, soil $DT_{50}$ values (preferred over soil $t_{½}$) would be used in evaluating the potential to degrade groundwater by leaching (see **Potential to Move to Groundwater** below), if available.
**Aquatic Persistence:** Service personnel would record values for aquatic $t_{½}$, which represents the length of time required for 50% of the deposited pesticide to degrade (completely or partially) in water. Based upon the $t_{½}$ value, aquatic persistence would be categorized as one of the following: nonpersistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et. al. 1996).

*Threshold for Approving PUPs:*

*If aquatic $t_{½}$ ≤100 days, then a PUP would be approved without additional BMPs to protect water quality.*
*If aquatic $t_{½}$ >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to minimize potential surface run-off and leaching that can degrade water quality:*

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10' and average annual precipitation >12".*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

**Aquatic Dissipation**: Dissipation time ($DT_{50}$) represents the time required for 50% of the deposited pesticide to degrade or move (dissipate); whereas, aquatic $t_{½}$ describes the rate for degradation only. As for $t_{½}$, units of dissipation time are usually expressed in days. Based upon the $DT_{50}$ value, environmental persistence in aquatic habitats also would be categorized as one of the following: nonpersistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days.

*Threshold for Approving PUPs:*

*If aquatic $DT_{50} \leq 100$ days, then a PUP would be approved without additional BMPs to protect water quality.*
*If aquatic $DT_{50} > 100$ days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to minimize potential surface run-off and leaching that can degrade water quality:*

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10' and average annual precipitation >12".*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

**Potential to Move to Groundwater:** Groundwater Ubiquity Score (GUS) = $\log_{10}(\text{soil } t_{½}) \times [4 - \log_{10}(K_{oc})]$. If a $DT_{50}$ value is available, it would be used rather than a $t_{½}$ value to calculate a GUS score. Based upon the GUS value, the potential to move toward groundwater would be recorded as one of the following categories: extremely low potential<1.0, low - 1.0 to 2.0, moderate - 2.0 to 3.0, high - 3.0 to 4.0, or very high>4.0.

*Threshold for Approving PUPs:*

*If GUS ≤4.0, then a PUP would be approved without additional BMPs to protect water quality.*
*If GUS >4.0, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to minimize potential surface run-off and leaching that can degrade water quality:*

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10' and average annual precipitation >12".*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

**Volatilization:** Pesticides may volatilize (evaporate) from soil and plant surfaces and move off-target into the atmosphere. The potential for a pesticide to volatilize is a function of its vapor pressure that is affected by temperature, sorption, soil moisture, and the pesticide"s water solubility. Vapor pressure is often expressed in mm Hg. To make these values easier to compare, vapor pressure would be recorded by Service personnel in exponential form ($I \times 10^{-7}$), where I represents a vapor pressure index. In general, pesticides with I<10 would have low potential to volatilize; whereas, pesticides with I >1,000 would have a high potential to volatilize (Oregon State University 1996).

Vapor pressure values for pesticides are usually available in the pesticide product MSDS or the USDA Agricultural Research Service (ARS) pesticide database (see **References**).

*Threshold for Approving PUPs:*

*If I ≤1000, then a PUP would be approved without additional BMPs to minimize drift and protect air quality.*
*If I >1000, then a PUP would only be approved with additional BMPs specifically to minimize drift and protect air quality. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to reduce volatilization and potential to drift and degrade air quality:*

- *Do not treat when wind velocities are <2 or >10 mph with existing or potential inversion conditions.*
- *Apply the large-diameter droplets possible for spray treatments.*
- *Avoid spraying when air temperatures >85°F.*
- *Use the lowest spray height possible above target canopy.*
- *Where identified on the pesticide label, soil incorporate pesticide as soon as possible during or after application.*

**Octanol-Water Partition Coefficient ($K_{ow}$):** The octanol-water partition coefficient ($K_{ow}$) is the concentration of a pesticide in octanol and water at equilibrium at a specific temperature. Because octanol is an organic solvent, it is considered a surrogate for natural organic matter. Therefore, $K_{ow}$ would be used to assess potential for a pesticide to bioaccumulate in tissues of aquatic species (e.g., fish). If $K_{ow}$ >1000 or $S_w$<1 mg/L AND soil $t_{½}$>30 days, then there would be high potential for a pesticide to bioaccumulate in aquatic species such as fish (US Geological Survey 2000).

*Threshold for Approving PUPs:*

*If there is not a high potential for a pesticide to bioaccumulate in aquatic species, then the PUP would be approved.*
*If there is a high potential to bioaccumulate in aquatic species ($K_{ow}$>1000 or $S_w$<1 mg/L AND soil $t_{½}$>30 days), then the PUP would not approved, except under unusual circumstances where approval would only be granted by the Washington Office.*

**Bioaccumulation/Bioconcentration:** The physiological process where pesticide concentrations in tissue would increase in biota because they are taken and stored at a faster rate than they are metabolized or excreted. The potential for bioaccumulation would be evaluated through bioaccumulation factors (BAFs) or bioconcentration factors (BCFs). Based upon BAF or BCF values, the potential to bioaccumulate would be recorded as one of the following: low – 0 to 300, moderate – 300 to 1000, or high >1000 (Calabrese and Baldwin 1993).

*Threshold for Approving PUPs:*

*If BAF or BCF≤1000, then a PUP would be approved without additional BMPs.*
*If BAF or BCF>1000, then a PUP would not approved, except under unusual circumstances where approval would only be granted by the Washington Office.*

***Worst-Case Ecological Risk Assessment***

**Max Application Rates (acid equivalent):** Service personnel would record the highest application rate of an active ingredient (ae basis) for habitat management and cropland/facilities maintenance treatments in this data field of a Chemical Profile. These rates can be found in Table CP.1 under the column heading "Max Product Rate – Single Application (lbs/acre – AI on acid equiv basis)". This table would be prepared for a chemical profile from information specified in labels for trade name products identified in PUPs. If these data are not available in pesticide labels, then write "NS" for "not specified on label" in this table.

**EECs:** An estimated environmental concentration (ECC) represents potential exposure to fish and wildlife (birds and mammals) from using a pesticide. EECs would be derived by Service personnel using an USEPA screening-level approach (US Environmental Protection Agency 2004). For each max application rate [see description under **Max Application Rates (acid equivalent)**], Service personnel would record 2 EEC values in a Chemical Profile; these would represent the worst-case terrestrial and aquatic exposures for habitat management and croplands/facilities maintenance treatments. For terrestrial and aquatic EEC calculations, see description for data entry under **Presumption of Unacceptable Risk/Risk Quotients**, which is the next field for a Chemical Profile.

**Presumption of Unacceptable Risk/Risk Quotients:** Service personnel would calculate and record acute and chronic risk quotients (RQs) for birds, mammals, and fish using the provided tabular formats for habitat management and/or cropland/facilities maintenance treatments. RQs recorded in a Chemical Profile would represent the worst-case assessment for ecological risk. See Section 7.2 for discussion regarding the calculations of RQs.

For aquatic assessments associated with habitat management treatments, RQ calculations would be based upon selected acute and chronic toxicological endpoints for fish and the EEC would be derived from Urban and Cook (1986) assuming 100% overspray to an entire 1-foot deep water body using the max application rate (ae basis [see above]).

For aquatic assessments associated with cropland/facilities maintenance treatments, RQ calculations would be done by Service personnel based upon selected acute and chronic toxicological endpoints for fish and an EEC would be derived from the aquatic assessment in AgDRIFT® model version 2.01 under Tier I ground-based application with the following input variables: max application rate (acid basis [see above]), low boom (20"), fine to medium/coarse droplet size, 20 swaths, EPA-defined wetland, and 25-foot distance (buffer) from treated area to water.

See Section 7.2.1.2 for more details regarding the calculation of EECs for aquatic habitats for habitat management and cropland/facilities maintenance treatments.

For terrestrial avian and mammalian assessments, RQ calculations would be done by Service personnel based upon dietary exposure, where the "short grass" food item category would represent the worst-case scenario. For terrestrial spray applications associated with habitat management and cropland/facilities maintenance treatments, exposure (EECs and RQs) would be determined using the Kanaga nomogram method through the USEPA‟s Terrestrial Residue Exposure model (T-REX) version 1.2.3. T-REX input variables would include the following: max application rate (acid basis [see above]) and pesticide half-life (days) in soil to estimate the initial, maximum pesticide residue concentration on general food items for terrestrial vertebrate species in short (<20 cm tall) grass.

For granular pesticide formulations and pesticide-treated seed with a unique route of exposure for terrestrial avian and mammalian wildlife, see Section 7.2.1.1.2 for the procedure that would be used to calculate RQs.

All calculated RQs in both tables would be compared with Levels of Concern (LOCs) established by USEPA (see Table 2 in Section 7.2). If a calculated RQ exceeds an established LOC value (in brackets inside the table), then there would be a potential for an acute or chronic effect (unacceptable risk) to federally listed (T&E) species and nonlisted species. See Section 7.2 for detailed descriptions of acute and chronic RQ calculations and comparison to LOCs to assess risk.

*Threshold for approving PUPs:*

*If RQs≤LOCs, then a PUP would be approved without additional BMPs.*
*If RQs>LOCs, then a PUP would only be approved with additional BMPs specifically to minimize exposure (ecological risk) to bird, mammal, and/or fish species. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to reduce potential risk to nonlisted or listed species:*

- *Lower application rate and/or fewer number of applications so RQs≤LOCs*
- *For aquatic assessments (fish) associated with cropland/facilities maintenance, increase the buffer distance beyond 25' so RQs≤LOCs.*

**Justification for Use:** Service personnel would describe the reason for using the pesticide based control of specific pests or groups of pests. In most cases, the pesticide label will provide the appropriate information regarding control of pests to describe in the section.

**Specific Best Management Practices (BMPs):** Service personnel would record specific BMPs necessary to minimize or eliminate potential effects to nontarget species and/or degradation of environmental quality from drift, surface runoff, or leaching. These BMPs would be based upon scientific information documented in previous data fields of a Chemical Profile. Where necessary and feasible, these specific practices would be included in PUPs as a basis for approval.

If there are no specific BMPs that are appropriate, then Service personnel would describe why the potential effects to Refuge resources and/or degradation of environmental quality is outweighed by the overall resource benefit(s) from the proposed pesticide use in the BMP section of the PUP. See Section 4.0 of this document for a complete list of BMPs associated with mixing and applying pesticides appropriate for all PUPs with ground-based treatments that would be additive to any necessary, chemical-specific BMPs.

**References:** Service personnel would record scientific resources used to provide data/information for a chemical profile. Use the number sequence to uniquely reference data in a chemical profile.

The following on-line data resources are readily available for toxicological endpoint and environmental fate data for pesticides:

1. California Product/Label Database. Department of Pesticide Regulation, California Environmental Protection Agency. (http://www.cdpr.ca.gov/docs/label/labelque.htm#regprods)

2. ECOTOX database. Office of Pesticide Programs, US Environmental Protection Agency, Washington, DC. (http://cfpub.epa.gov/ecotox/)

3. Extension Toxicology Network (EXTOXNET) Pesticide Information Profiles. Cooperative effort of University of California-Davis, Oregon State University, Michigan State University, Cornell University and University of Idaho through Oregon State University, Corvallis, Oregon. (http://extoxnet.orst.edu/pips/ghindex.html)

4. FAO specifications and evaluations for plant protection products. Pesticide Management Unit, Plant Protection Services, Food and Agriculture Organization, United Nations. (http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGP/AGPP/Pesticid/)

5. Human health and ecological risk assessments. Pesticide Management and Coordination, Forest Health Protection, US Department of Agriculture, US Forest Service. (http://www.fs.fed.us/foresthealth/pesticide/risk.htm)

6. Pesticide Chemical Fact Sheets. Clemson University Pesticide Information Center. (http://entweb.clemson.edu/pesticid/Document/Labels/factshee.htm)

7. Pesticide Fact Sheets. Published by Information Ventures, Inc. for Bureau of Land Management, Dept. of Interior; Bonneville Power Administration, U.S. Dept. of Energy; and Forest Service, US Department of Agriculture. (http://infoventures.com/e-hlth/pesticide/pest-fac.html)

8. Pesticide Fact Sheets. National Pesticide Information Center. (http://npic.orst.edu/npicfact.htm)

9. Pesticide Fate Database. US Environmental Protection Agency, Washington, DC. (http://cfpub.epa.gov/pfate/home.cfm).

10. Pesticide product labels and material safety data sheets. Crop Data Management Systems, Inc. (CDMS) (http://www.cdms.net/pfa/LUpdateMsg.asp) or multiple websites maintained by agrichemical companies.

11. Registered Pesticide Products (Oregon database). Oregon Department of Agriculture. (http://www.oda.state.or.us/dbs/pest_products/search.lasso)

12. Regulatory notes. Pest Management Regulatory Agency, Health Canada, Ontario, Canada. (http://www.hc-sc.gc.ca/pmra-arla/)

13. Reptile and Amphibian Toxicology Literature. Canadian Wildlife Service, Environment Canada, Ontario, Canada. (http://www.cws-scf.ec.gc.ca/nwrc-cnrf/ratl/index_e.cfm)

14. Specific Chemical Fact Sheet – New Active Ingredients, Biopesticide Fact Sheet and Registration Fact Sheet. U.S Environmental Protection Agency, Washington, DC. (http://www.epa.gov/pestidides/factsheets/chemical_fs.htm)

15. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas. The Invasive Species Initiative. The Nature Conservancy. (http://tnsweeds.ucdavis.edu/handbook.html)

16. Wildlife Contaminants Online. US Geological Survey, Department of Interior, Washington, D.C. (http://www.pwrc.usgs.gov/contaminants-online/)

17. One-liner database. 2000. US Environmental Protection Agency, Office of Pesticide Programs, Washington, D.C.

**Chemical Profile**

| | | | |
|---|---|---|---|
| **Date:** | | | |
| **Trade Name(s):** | | **Common Chemical Name(s):** | |
| **Pesticide Type:** | | **EPA Registration Number:** | |
| **Pesticide Class:** | | **CAS Number:** | |
| **Other Ingredients:** | | | |

**Toxicological Endpoints**

| | |
|---|---|
| **Mammalian $LD_{50}$:** | |
| **Mammalian $LC_{50}$:** | |
| **Mammalian Reproduction:** | |
| **Avian $LD_{50}$:** | |
| **Avian $LC_{50}$:** | |
| **Avian Reproduction:** | |
| **Fish $LC_{50}$:** | |
| **Fish ELS/Life Cycle:** | |
| **Other:** | |

**Ecological Incident Reports**

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|---|
| |

**Environmental Fate**

| | |
|---|---|
| **Water solubility ($S_w$):** | |
| **Soil Mobility ($K_{oc}$):** | |
| **Soil Persistence ($t_{½}$):** | |
| **Soil Dissipation ($DT_{50}$):** | |
| **Aquatic Persistence ($t_{½}$):** | |
| **Aquatic Dissipation ($DT_{50}$):** | |
| **Potential to Move to Groundwater (GUS score):** | |
| **Volatilization (mm Hg):** | |
| **Octanol-Water Partition Coefficient ($K_{ow}$):** | |
| **Bioaccumulation/Biocentration:** | **BAF:`**<br>**BCF:** |

**Worst Case Ecological Risk Assessment**

| | |
|---|---|
| **Max Application Rate (ai lbs/acre – ae basis)** | **Habitat Management:**<br>**Croplands/Facilities Maintenance:** |
| **EECs** | **Terrestrial (Habitat Management):**<br>**Terrestrial (Croplands/Facilities Maintenance):**<br>**Aquatic (Habitat Management):**<br>**Aquatic (Croplands/Facilities Maintenance):** |

Habitat Management Treatments:

| **Presumption of Unacceptable Risk** | | **Risk Quotient (RQ)** | |
|---|---|---|---|
| | | **Listed (T&E) Species** | **Nonlisted Species** |
| Acute | Birds | [0.1] | [0.5] |
| | Mammals | [0.1] | [0.5] |
| | Fish | [0.05] | [0.5] |
| Chronic | Birds | [1] | [1] |
| | Mammals | [1] | [1] |
| | Fish | [1] | [1] |

Cropland/Facilities Maintenance Treatments:

| **Presumption of Unacceptable Risk** | | **Risk Quotient (RQ)** | |
|---|---|---|---|
| | | **Listed (T&E) Species** | **Nonlisted Species** |
| Acute | Birds | [0.1] | [0.5] |
| | Mammals | [0.1] | [0.5] |
| | Fish | [0.05] | [0.5] |
| Chronic | Birds | [1] | [1] |
| | Mammals | [1] | [1] |
| | Fish | [1] | [1] |

| | |
|---|---|
| **Justification for Use:** | |
| **Specific Best Management Practices (BMPs):** | |
| **References:** | |

Table CP.1 Pesticide Name

| Trade Name[a] | Treatment Type[b] | Max Product Rate – Single Application (lbs/acre or gal/acre) | Max Product Rate -Single Application (lbs/acre - AI on acid equiv basis) | Max Number of Applications Per Season | Max Product Rate Per Season (lbs/acre/season or gal/acre/season) | Minimum Time Between Applications (Days) |
|---|---|---|---|---|---|---|
| | | | | | | |

[a]From each label for a pesticide identified in pesticide use proposals (PUPs), Service personnel would record application information associated with possible/known uses on Service lands.
[b]Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

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# Appendix G: Statement of Compliance

**for Implementation of the James Campbell National Wildlife Refuge, Honolulu County, Hawai‘i Comprehensive Conservation Plan**

The following Executive orders and legislative acts have been reviewed as they apply to implementation of the James Campbell NWR CCP.

**National Environmental Policy Act (1969).** The planning process has been conducted in accordance with NEPA Implementing Procedures, Department of the Interior and Service procedures, and has been performed in coordination with the affected public.

The CCP is programmatic in many respects and specific details of certain projects and actions cannot be determined until a later date depending on funding and implementation schedules. Certain projects or actions may require additional NEPA compliance.

**National Historic Preservation Act (1966).** The implementation of the CCP should not affect cultural resources. The proposed action does not meet the criteria of an effect or adverse effect as an undertaking defined in 36 CFR 800.9 and 614 FW 2. The Service will comply with the National Historic Preservation Act if any management actions have the potential to affect any historic properties which may be present.

**Executive Order 12372. Intergovernmental Review.** Coordination and consultation with affected Tribal, local, and State governments, other Federal agencies, and the landowners has been completed through personal contact by Service planners, refuge managers, and supervisors.

**Executive Order 12898. Federal Actions to Address Environmental Justice in Minority and Low-Income Populations.** All Federal actions must address and identify, as appropriate, disproportionally high and adverse human health or environmental effects of its programs, policies, and activities on minority populations, low-income populations, and Indian Tribes in the United States. The CCP was evaluated and no adverse human health or environmental effects were identified for minority or low-income populations, Indian Tribes, or anyone else.

**Wilderness Preservation Act of 1964.** The Service has evaluated the suitability of the Refuge for wilderness designation and determined it does not qualify.

**National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd-668ee).** Appropriate Use findings and Compatibility Determinations have been prepared for the following uses: Wildlife Observation, Interpretation and Photography; Environmental Education; and Research.

**Executive Order 13186. Responsibilities of Federal Agencies to Protect Migratory Birds.** The CCP is consistent with Executive Order 13186 because the CCP and NEPA analyses evaluate the effects of agency actions on migratory birds.

**Endangered Species Act of 1973.** The Service will conduct consultations under Section 7 of the ESA for any refuge management program actions that have the potential to affect listed species.

**Coastal Zone Management Act, Section 307.** Section 307(c)(1) of the Coastal Zone Management Act of 1972, as amended, requires each Federal agency conducting or supporting activities directly affecting the coastal zone, to conduct or support those activities in a manner which is, to the maximum extent practicable, consistent with approved state coastal management programs. The CCP is consistent with Coastal Zone Management Act because CCP implementation would protect the coastal zone from adverse impacts as a result of modification or destruction.

**Executive Order 11990. Protection of Wetlands.** The CCP is consistent with Executive Order 11990 because CCP implementation would protect and enhance existing wetlands.

**Executive Order 11988. Floodplain Management.** Under this order Federal agencies "shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by flood plains." The CCP is consistent with Executive Order 11988 because CCP implementation would protect floodplains from adverse impacts as a result of modification or destruction.

**Integrated Pest Management (IPM), 517 DM 1 and 569 FW 1.** In accordance with 517 DM 1, and 569 FW1, an integrated pest management (IPM) approach has been adopted to eradicate, control, or contain pest and invasive species on the Refuge. In accordance with 517 DM 1, only pesticides registered with the Environmental Protection Agency (EPA) in full compliance with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and as provided in regulations, orders, or permits issued by EPA, may be applied on lands and waters under Refuge jurisdiction.

_____ _____

Chief, Division of Planning, Visitor Services, and Transportation

Date

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